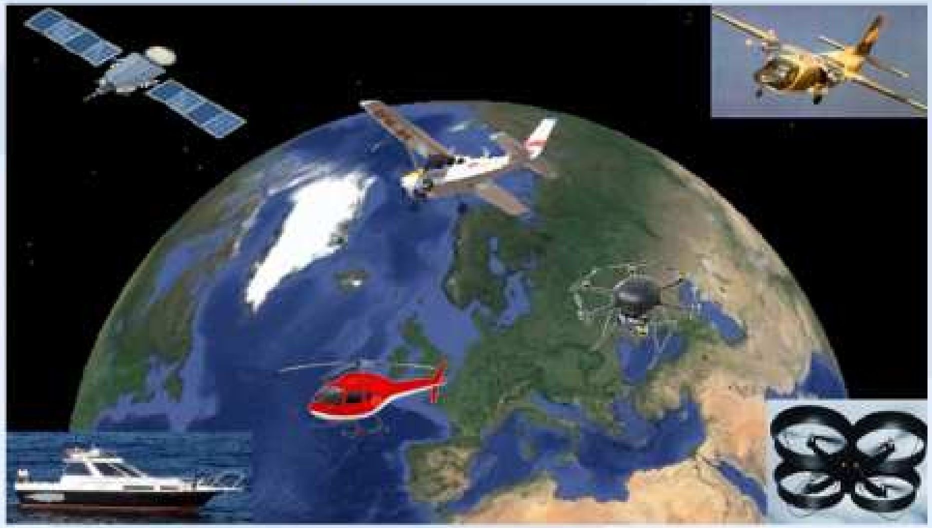
Facultat de Física

Universitat de València

Dijous 30 d'octubre del 2014, 12:30 hores
Saló d'Actes de la Biblioteca de Ciències "Eduard Boscà"
Campus de Burjassot

Estudi de contaminació d'aigües per mitjà de teledetecció



Prof. José Antonio Domínguez Gómez
Departament de Física Matemàtica i de Fluids.
Universitat Nacional d'Educació a Distància (UNED)

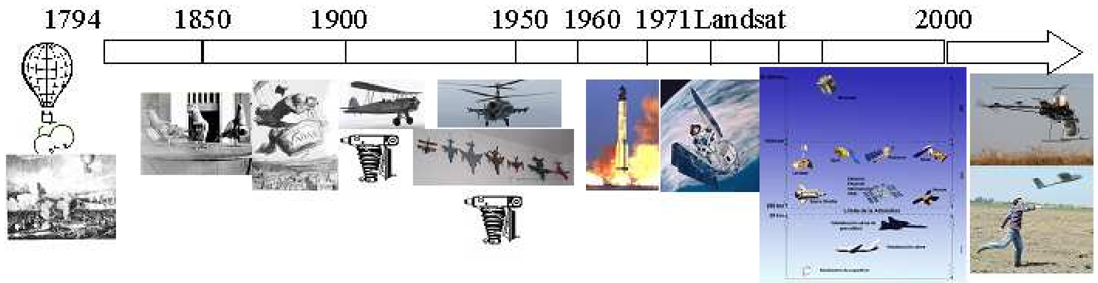
Facultat de Física

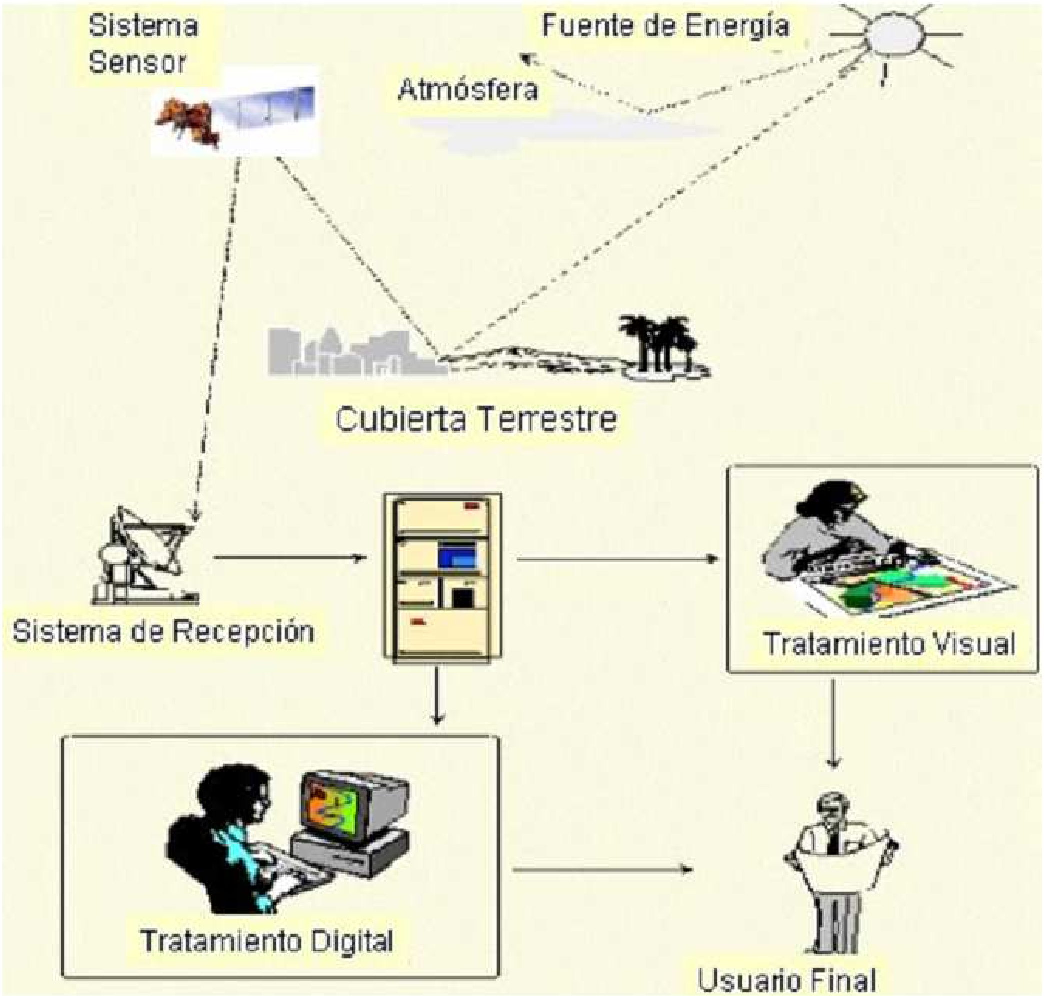
Estudio de Contaminación de Aguas mediante Teledetección

Dr. Jose Antonio Domínguez Gómez (jadomin@dfmf.uned.es)
Dpto de Física Matemática y de Fluidos. Facultad de Ciencias, UNED,
Coordinador del Grupo Temático de Limnología y Aguas Continentales de la Asociación Española de Teledetección

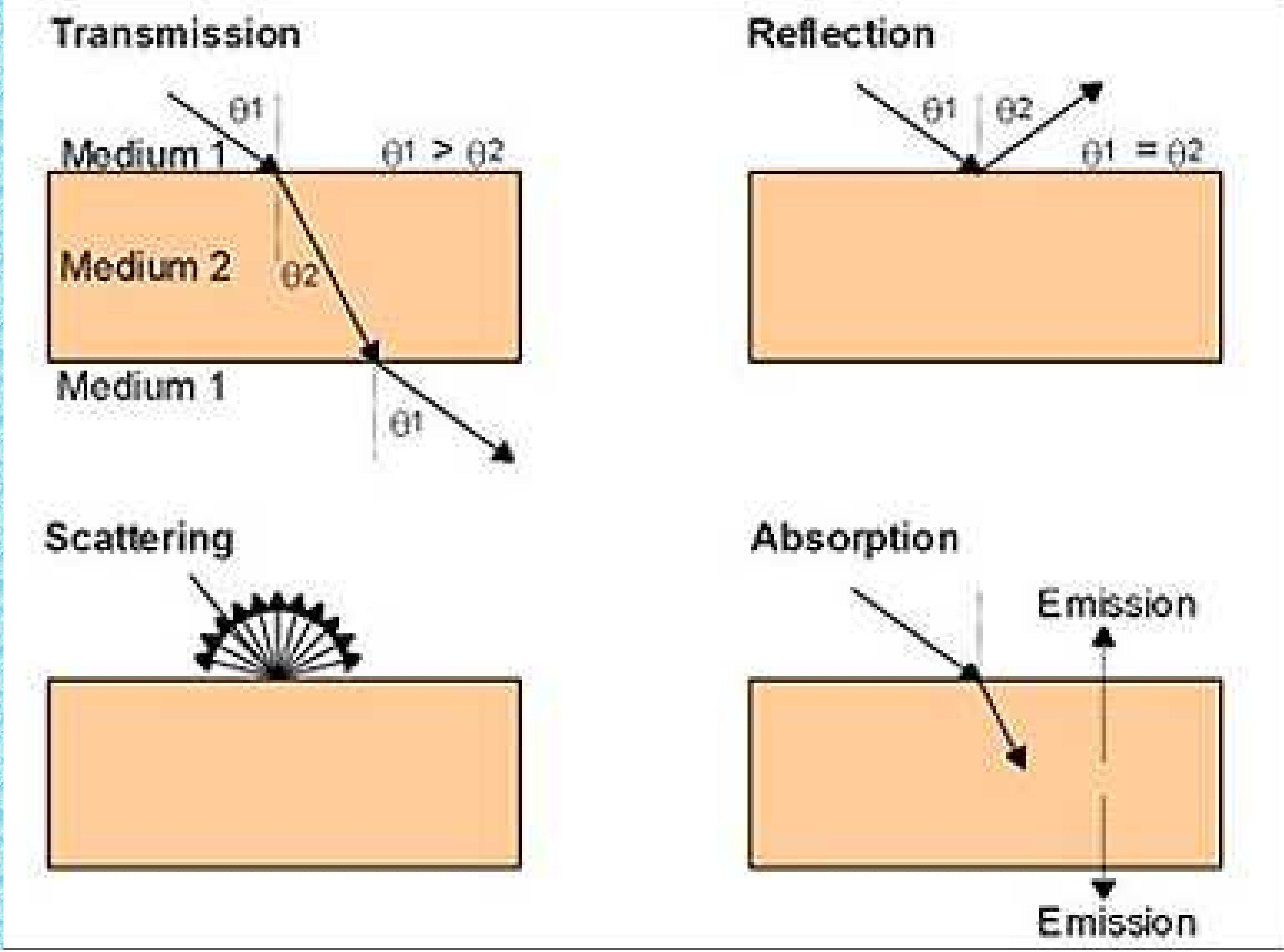
1.- INTRODUCCIÓN A LA TELEDETECCIÓN
2.- DIFERENCIAS DE LA TELEDETECCIÓN TERRESTRE Y ACUÁTICA
3.- PROPIEDADES ÓPTICAS DEL AGUA
4.- TELEDETECCIÓN EN ECOSISTEMAS ACUÁTICOS
5.-CONTAMINACIÓN DE AGUAS MEDIANTE TELEDETECCIÓN
6.- CONCLUSIÓN

1.- INTRODUCCIÓN A LA TELEDETECCIÓN





TELEDETECCIÓN

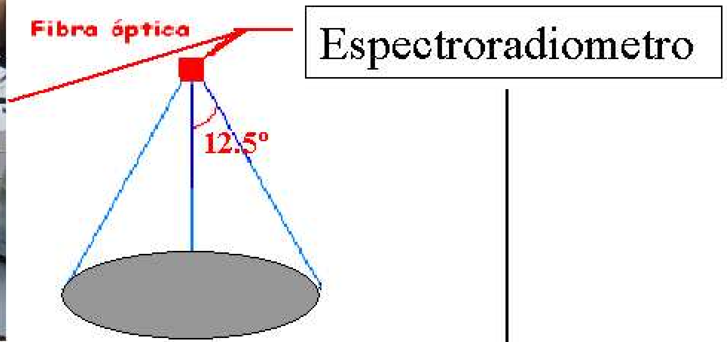


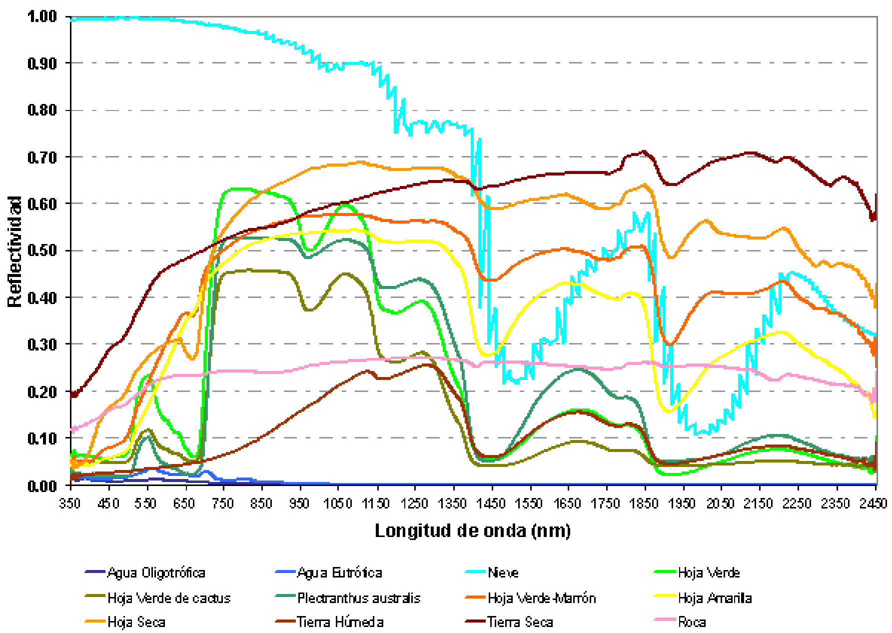
Transmission
θ1
Medium 1
θ1 > θ2
Medium 2
θ2
Medium 1
θ1
Reflection
θ1
θ2
θ1 = θ2
Scattering
Absorption
Emission
Emission

1.- INTRODUCCIÓN A LA TELEDETECCIÓN

La energía total $E = E_T + E_A + E_R$ $1 = (E_T + E_A + E_R)/E$ $\tau + \alpha + \rho = 1$

- τ (Transmitancia) es el porcentaje de energía que se transmite.
- α (Absorbancia) es el porcentaje de energía que se absorbe.
- ρ (Reflectancia) es el porcentaje de energía que se refleja.

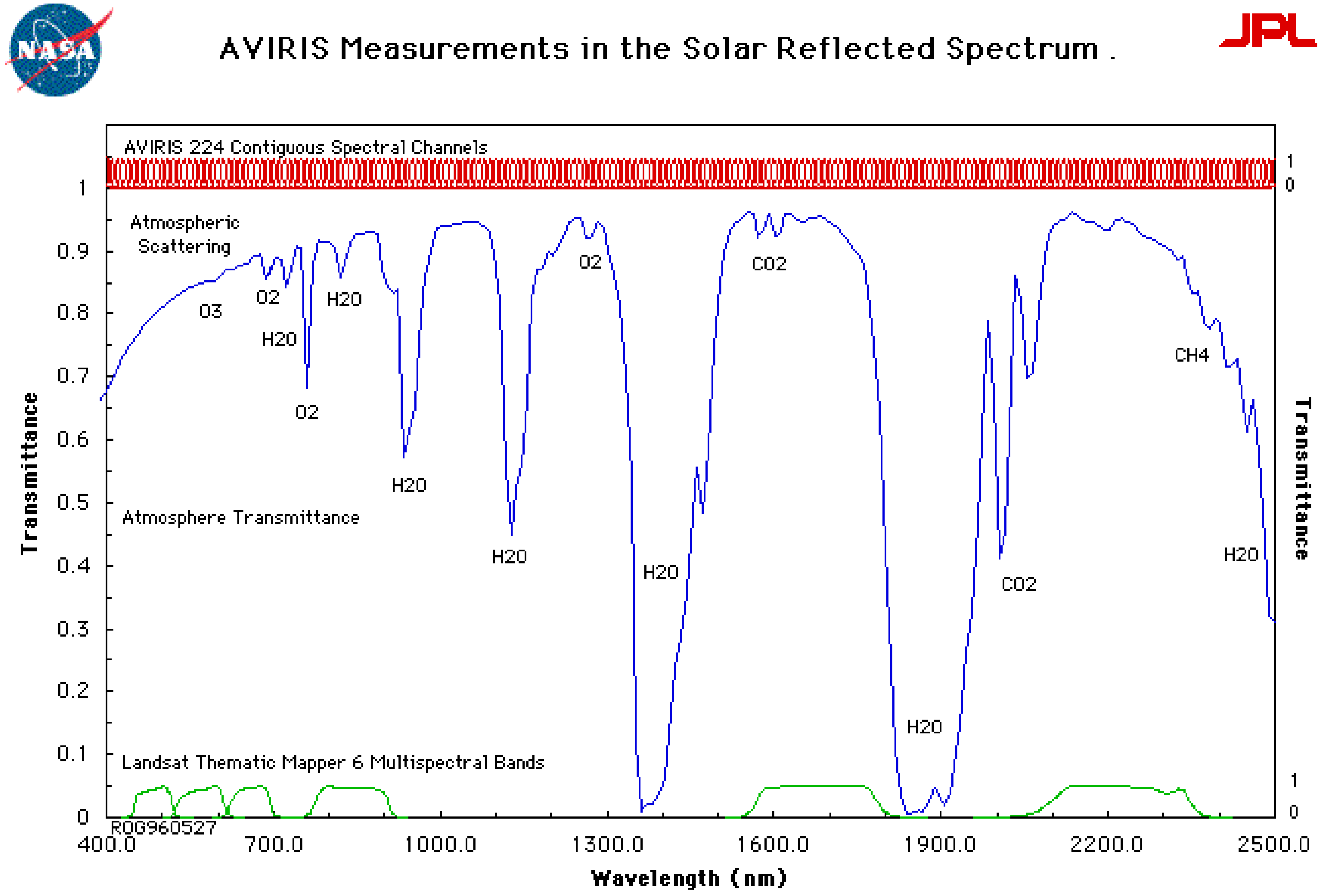




1.- INTRODUCCIÓN A LA TELEDETECCIÓN

http://profesor-rafazamora.blogspot.com.es/2011/11/lo-grande-y-lo-pequeno.html

1.- INTRODUCCIÓN A LA TELEDETECCIÓN



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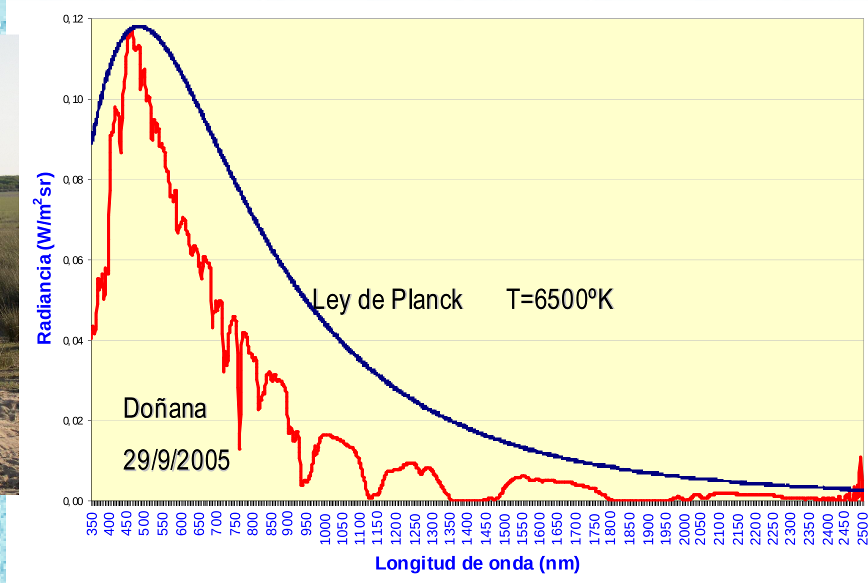
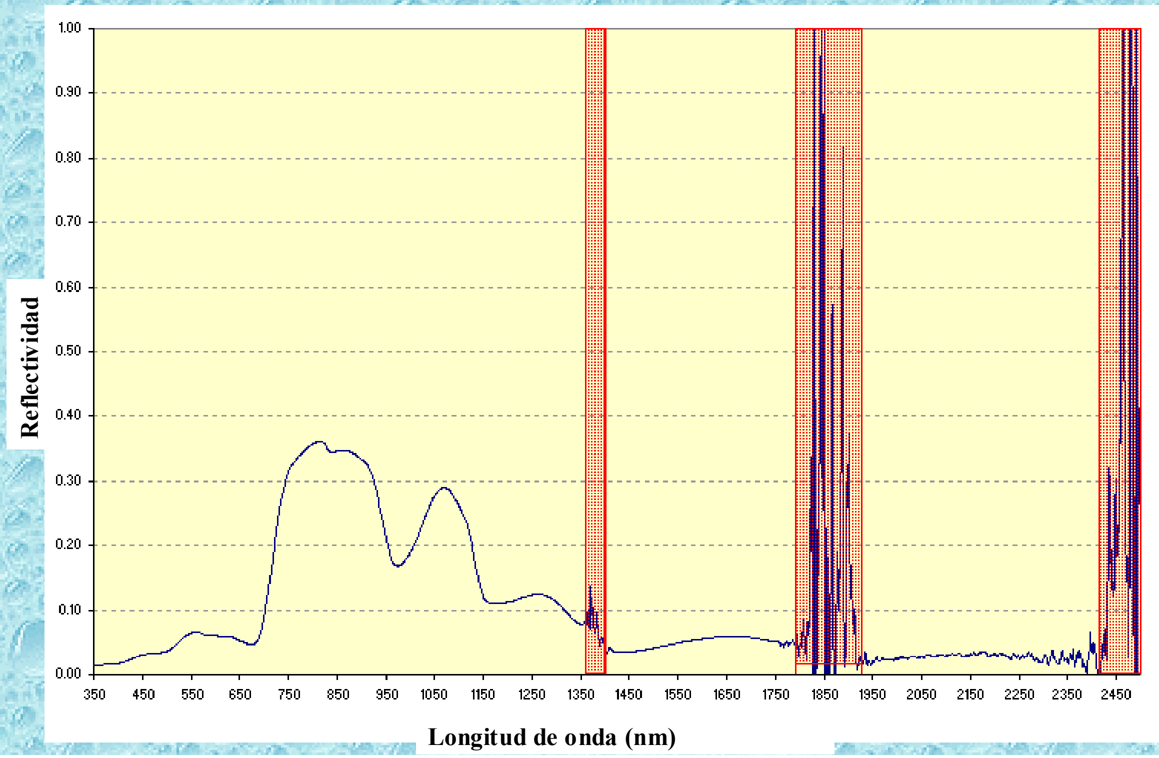
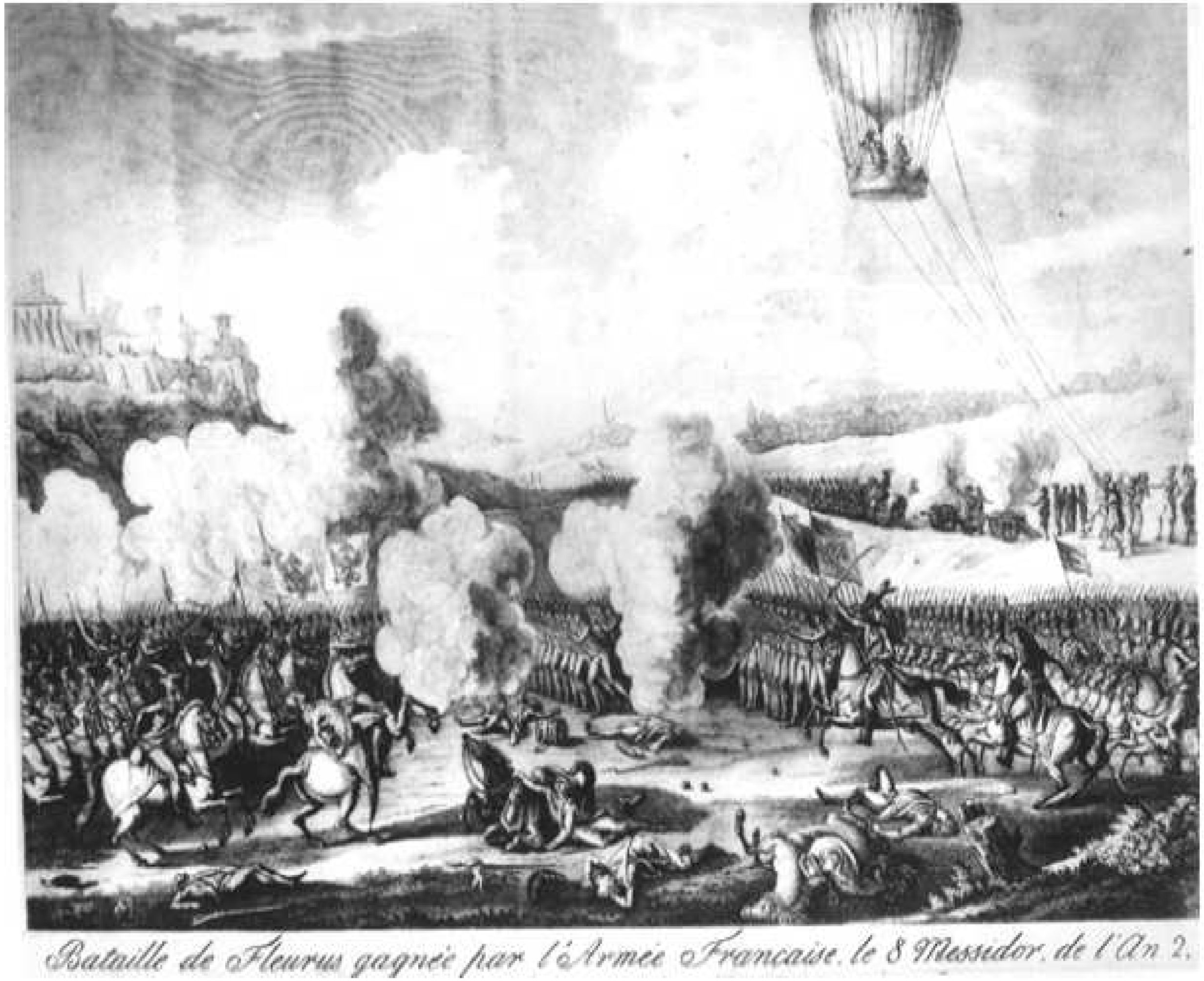
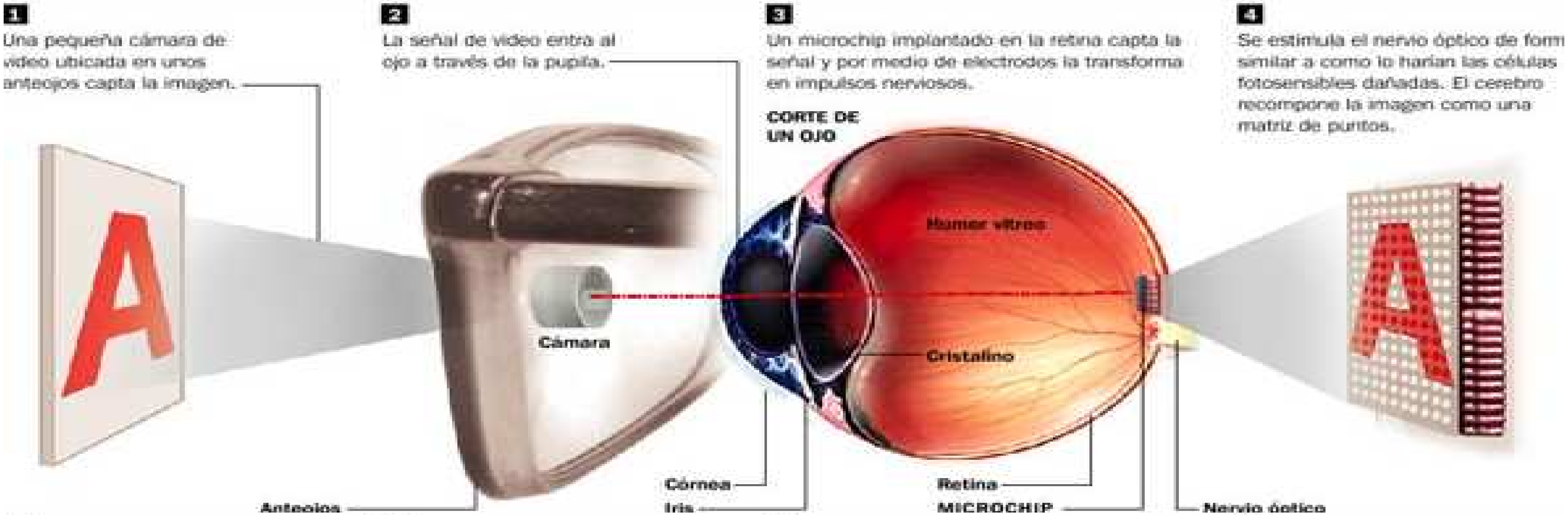


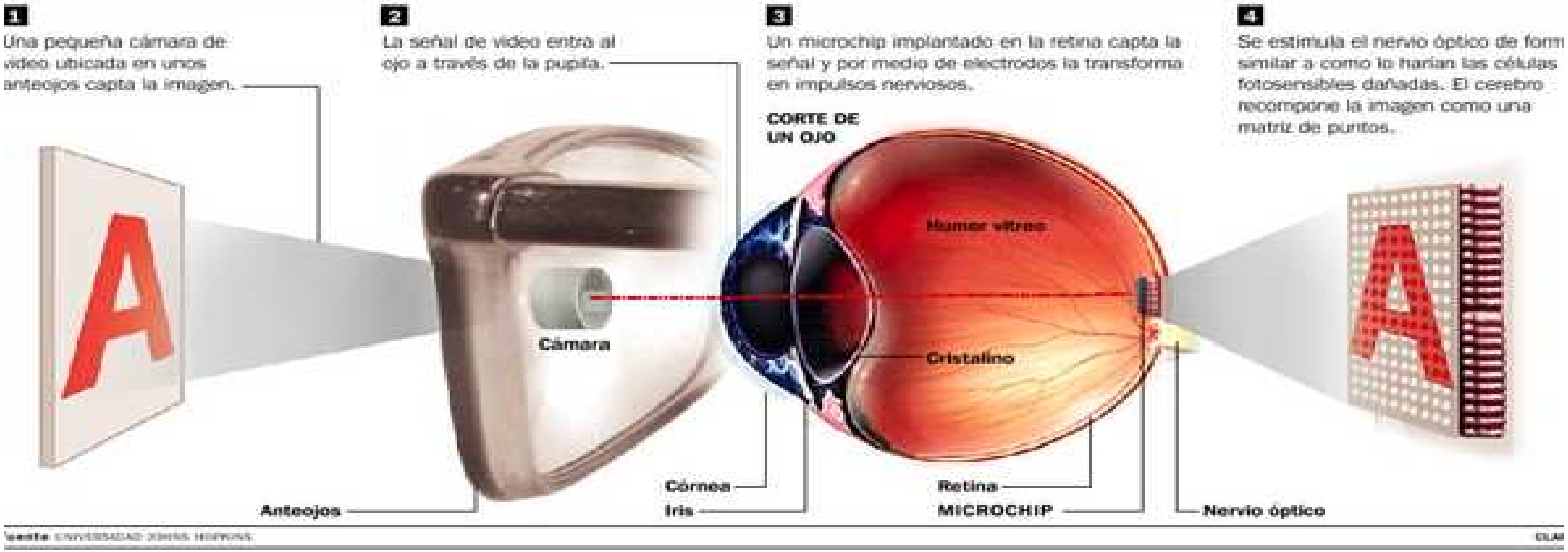




L'Entrepremant en la Batalla de Fleurus ganada por el Ejército Francés al austríaco el 26 de Junio de 1794 (National Air and Space Museum, Smithsonian Institution, Washington No. 76-1196).

1.- INTRODUCCIÓN A LA TELEDETECCIÓN





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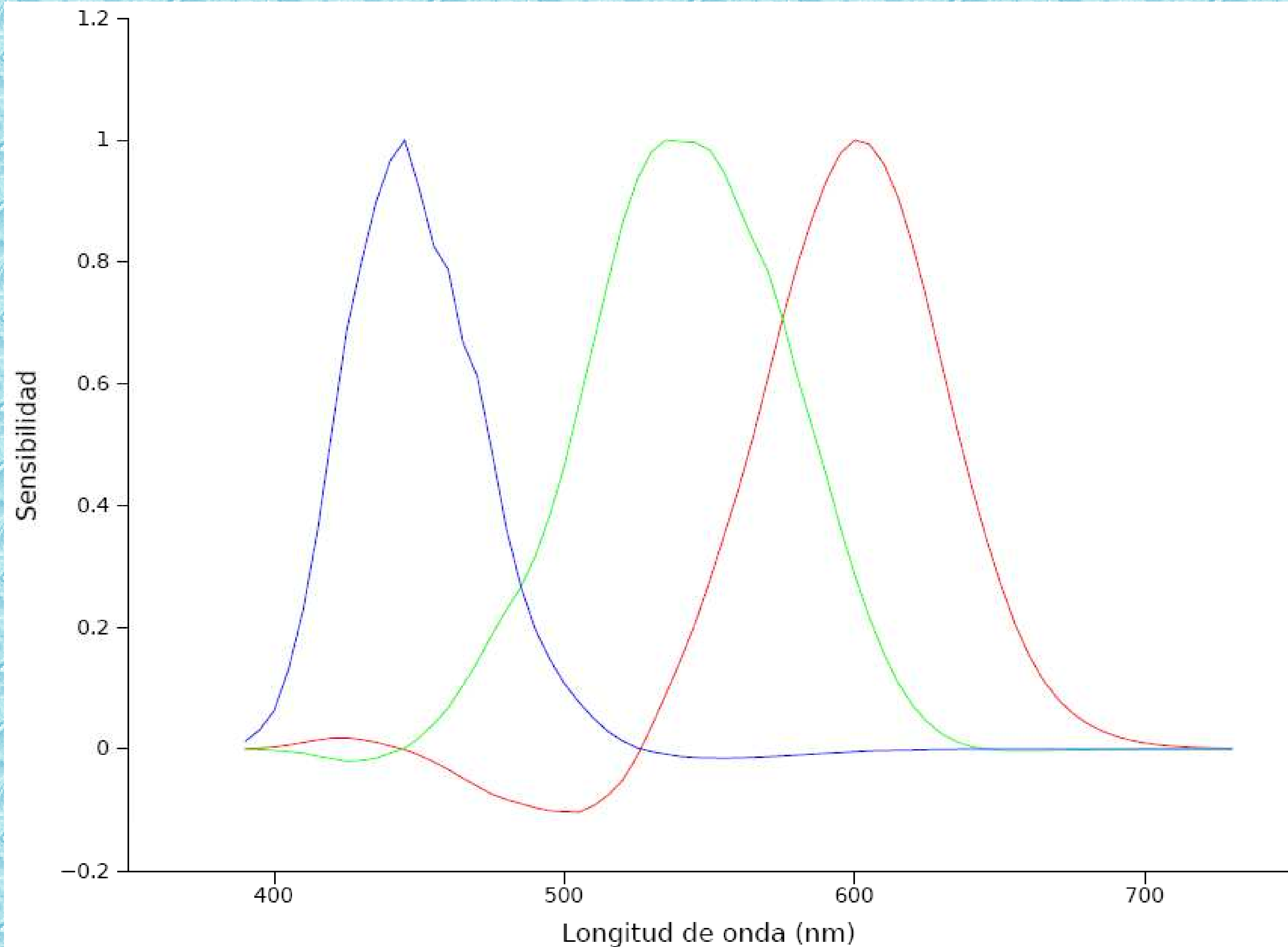
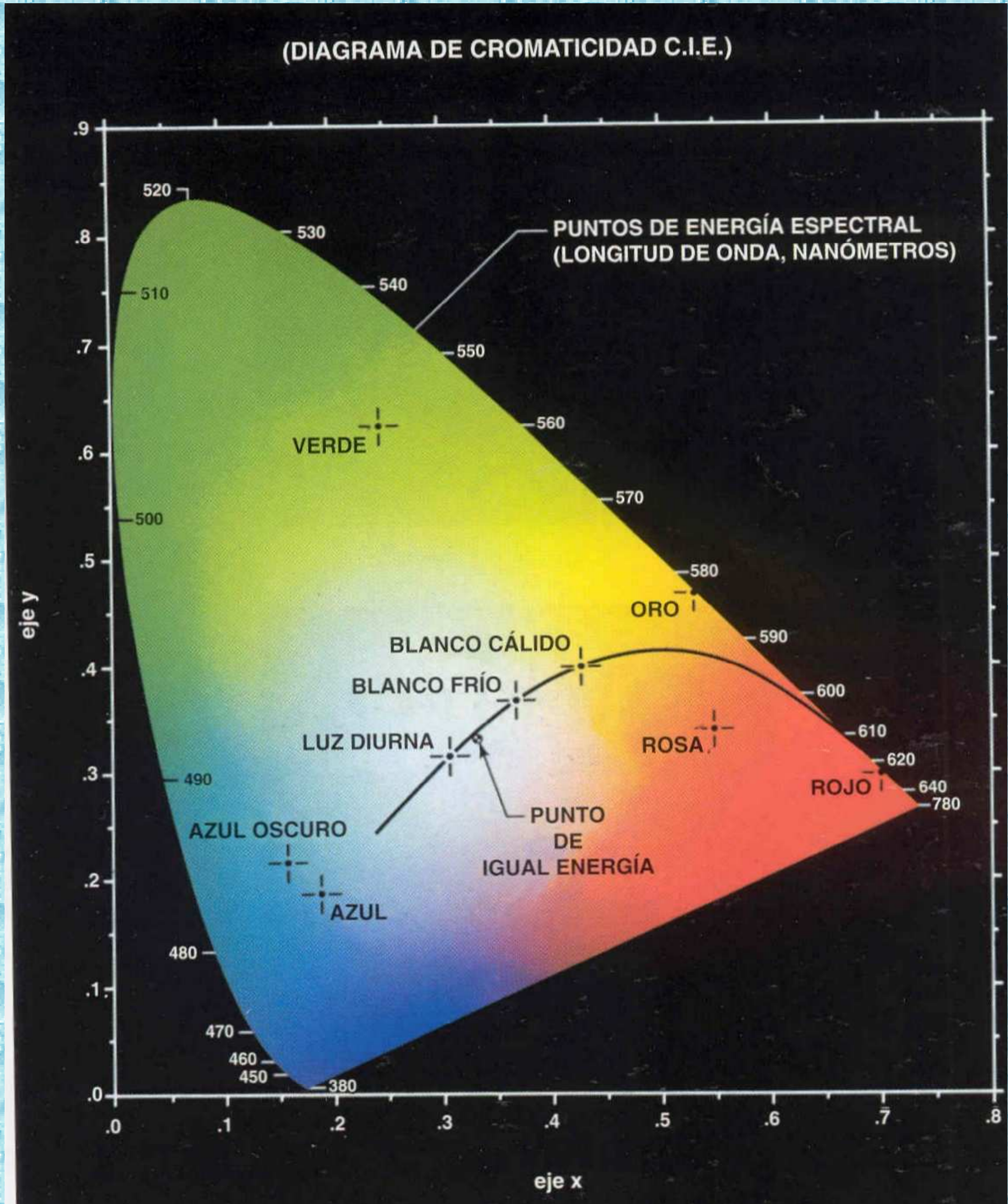
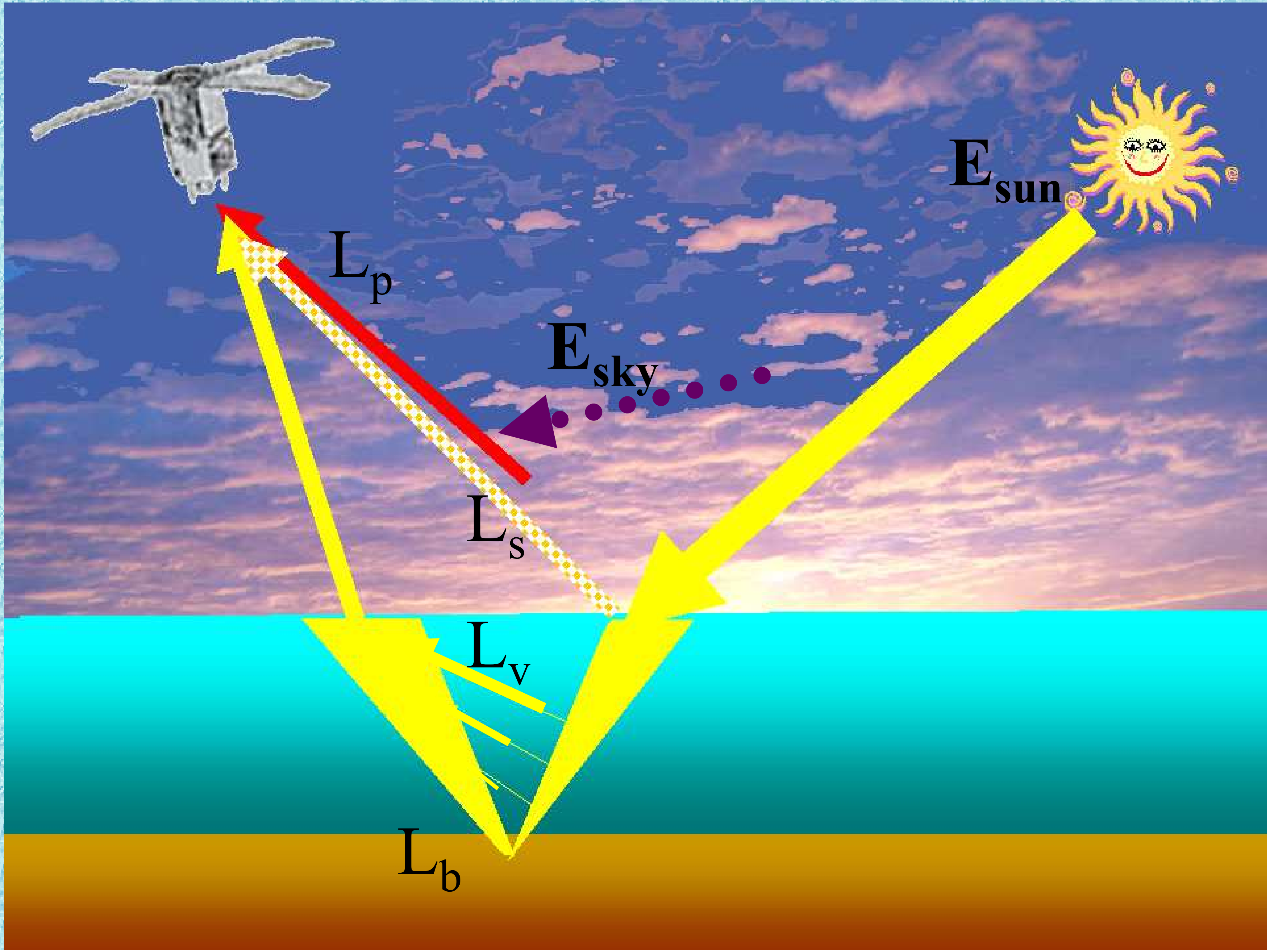


Ventanas espectrales de un ojo estándar (Domínguez 2012)

1.- INTRODUCCIÓN A LA TELEDETECCIÓN



2.- DIFERENCIAS DE LA TELEDETECCIÓN TERRESTRE Y ACUÁTICA



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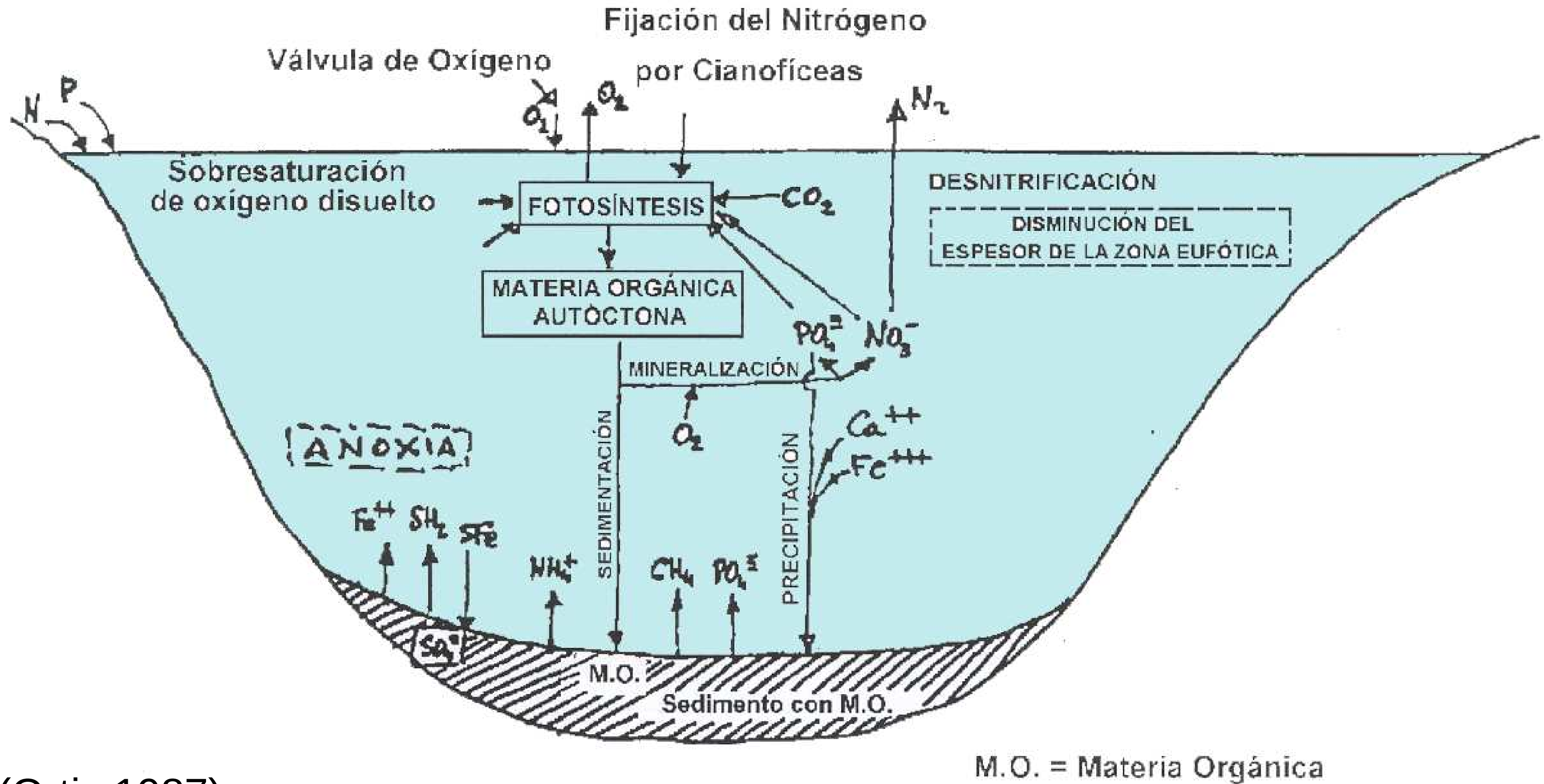


(Ortiz 1987)

Comportamiento de la Energía en el Agua

Lambert-Beer: $E_d(\lambda,z) = E_d(\lambda,0^-)\cdot e^{-kd(\lambda)z}$

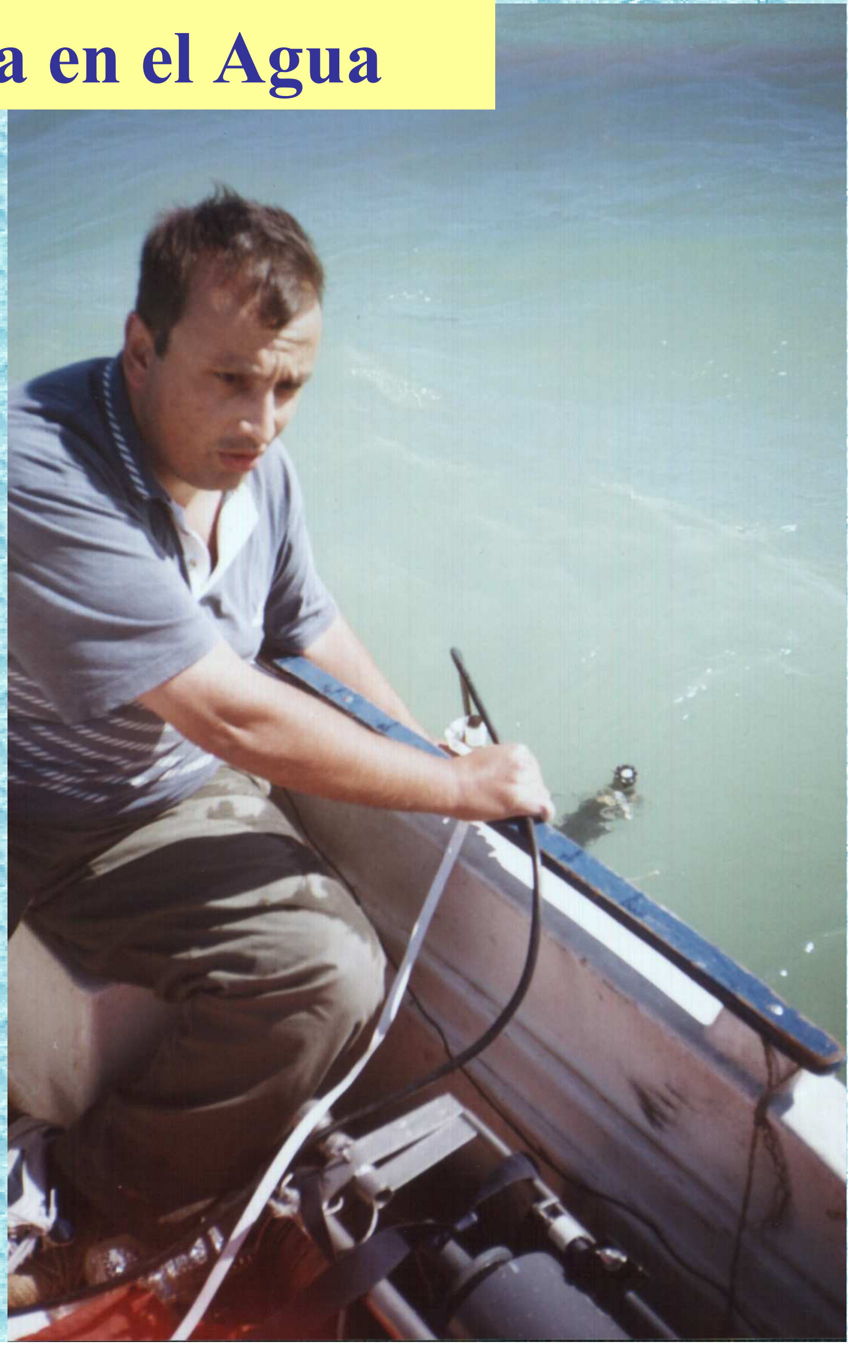
$E_d(\lambda,z)$ Irradiancia incidente a la profundidad z y a la longitud de onda λ.

$E_d(\lambda,0^-)$ Irradiancia a la superficie interior del agua (z=0) y a la longitud de onda λ.

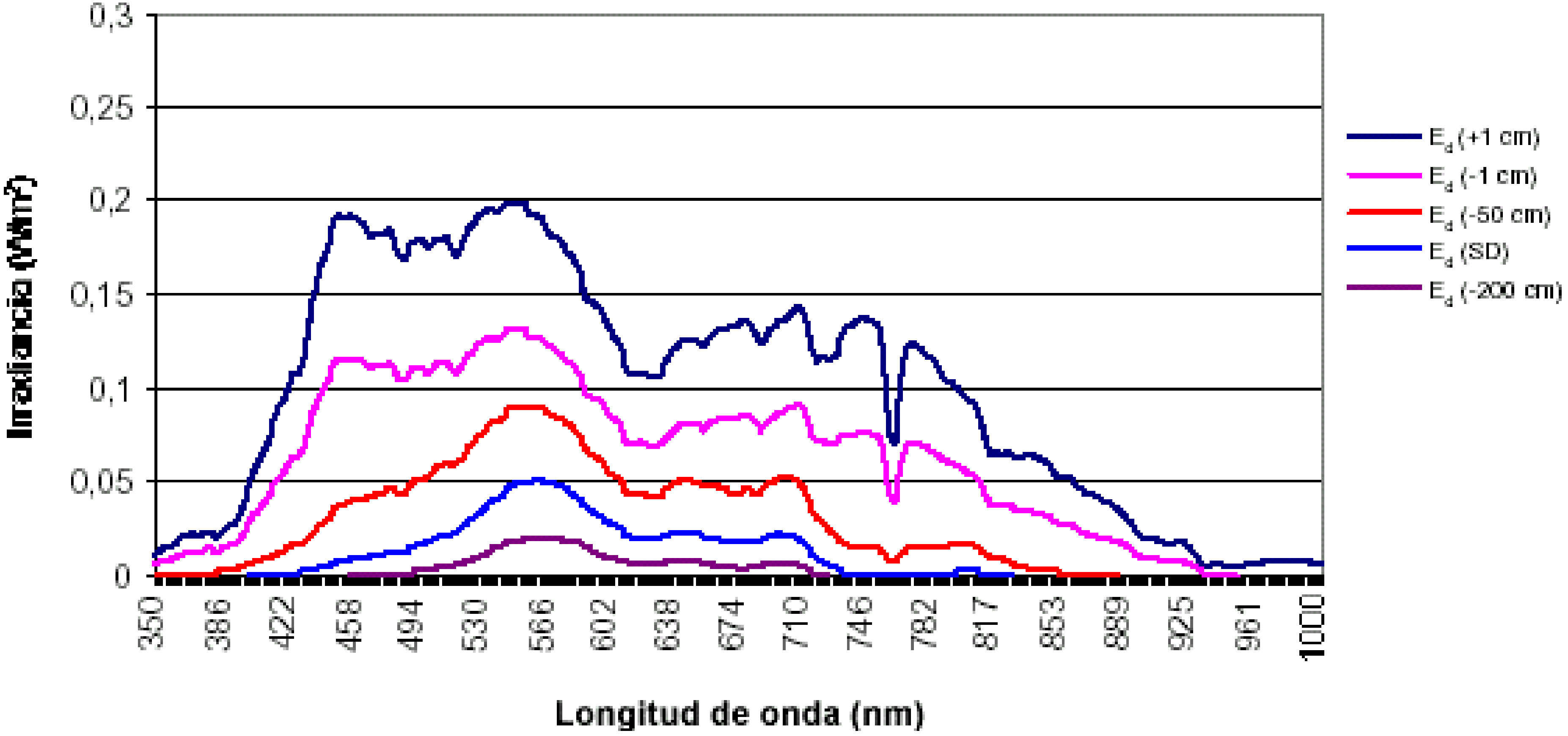
K_d (λ) coeficiente de atenuación difusa a la longitud de onda λ. Es la disminución de la irradiancia ambiental en el medio acuático.

La ley de Lambert-Beer se puede expresar en función del espesor óptico $\zeta=k_d(\lambda)z$

$E_d(\lambda,z) = E_d(\lambda,0)\cdot e^{-\zeta}$



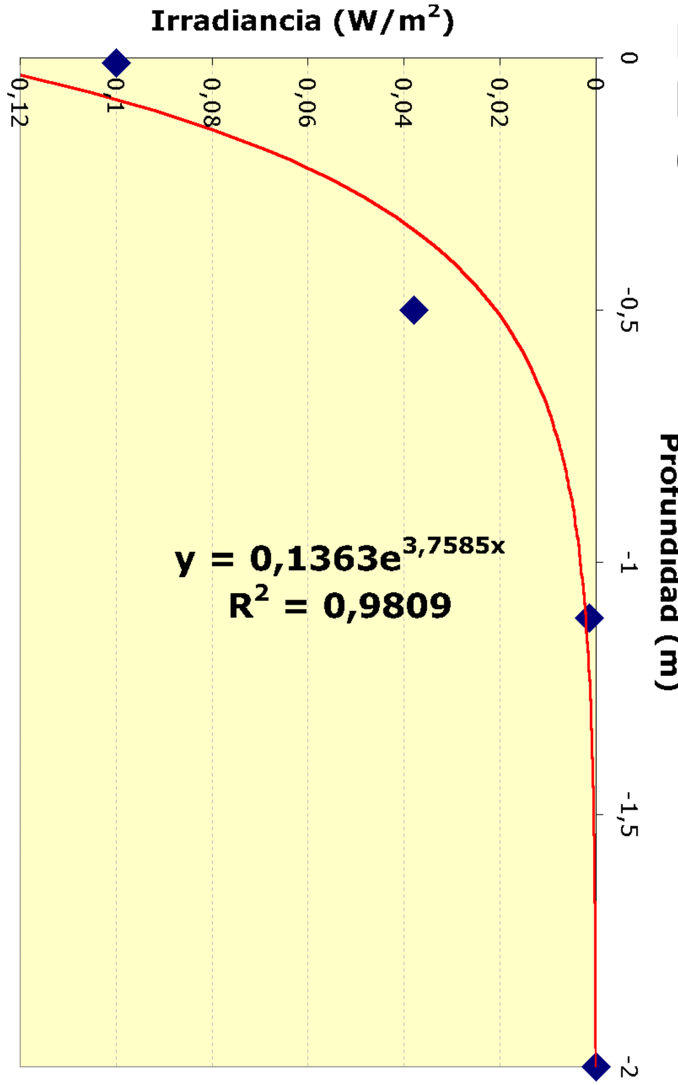
Comportamiento de la Energía en el Agua



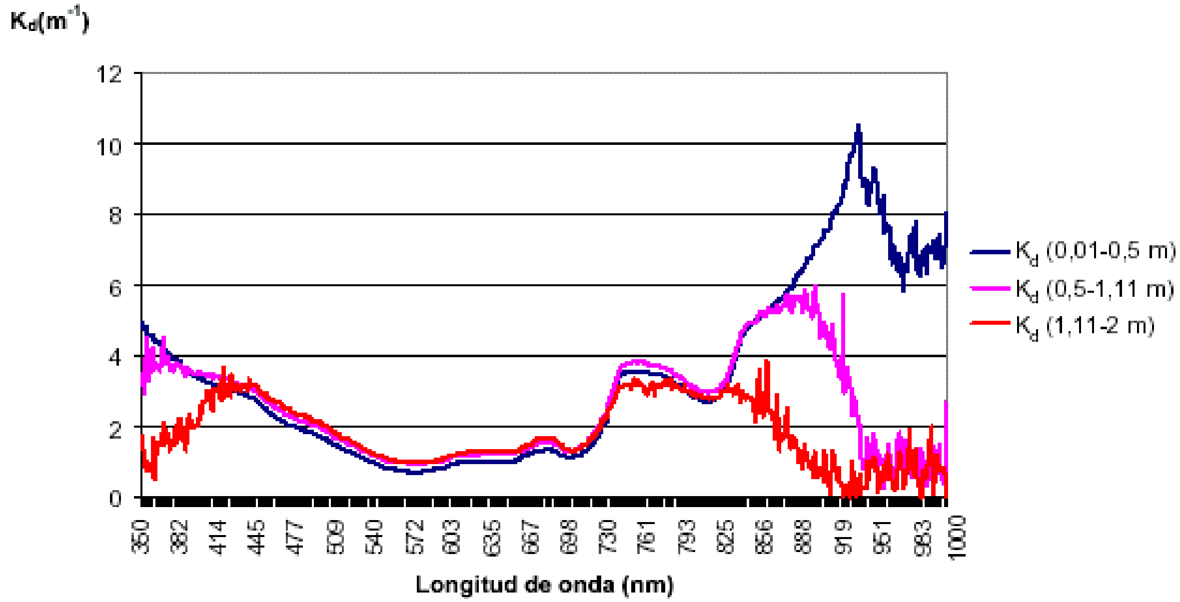
Irradiancia solar en el punto 5 de la laguna de El Campillo (31 de julio de 2000).

Comportamiento de la Energía en el Agua

Ley Lambert-Beer: $(E_d(\lambda,z)=E_d(\lambda,0)\exp(-k_d(\lambda)z))$

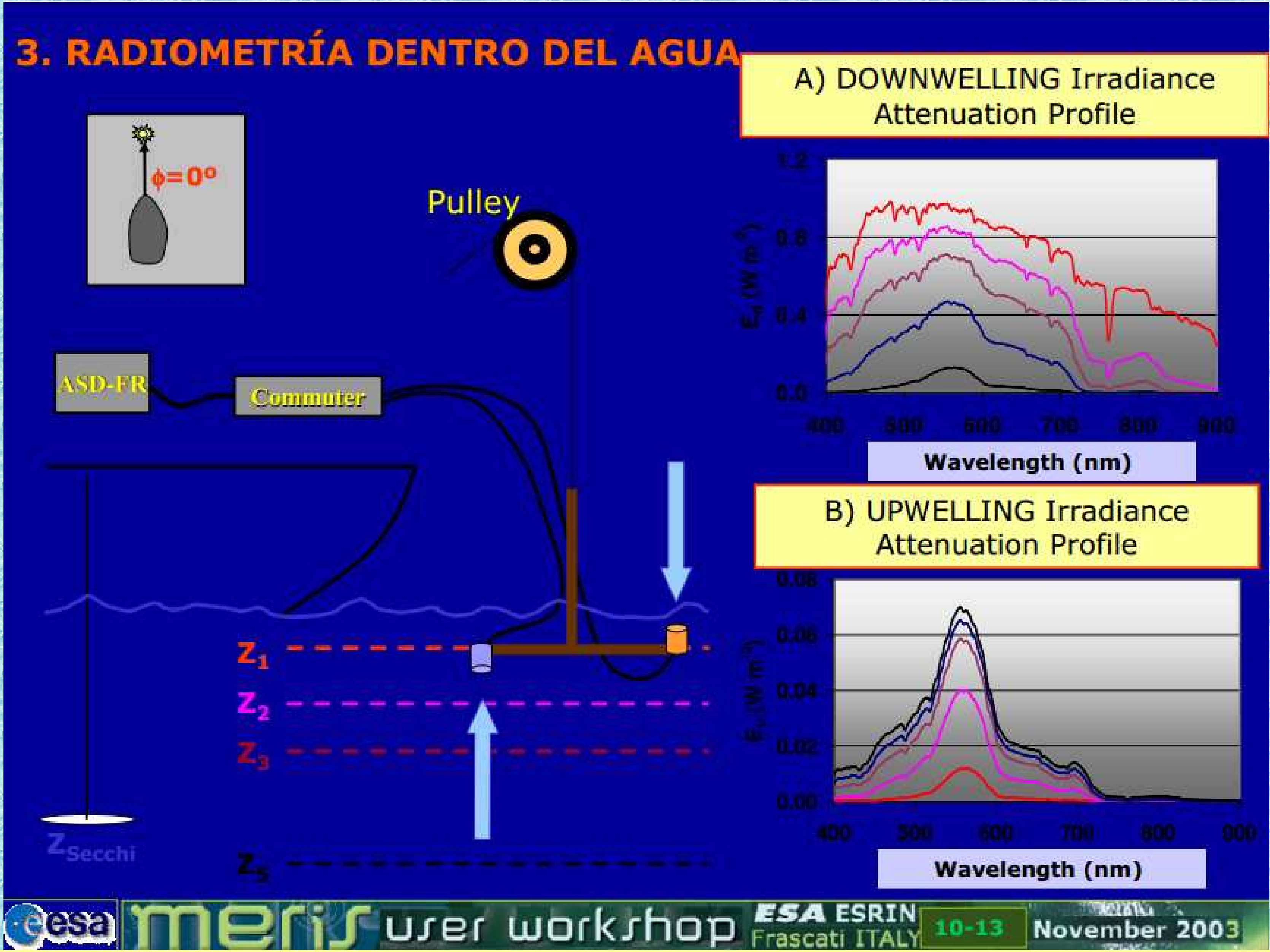


Kd a 430 nm en el punto 5 de la laguna de El Campillo (31 de julio de 2000) (Domínguez, 2002)



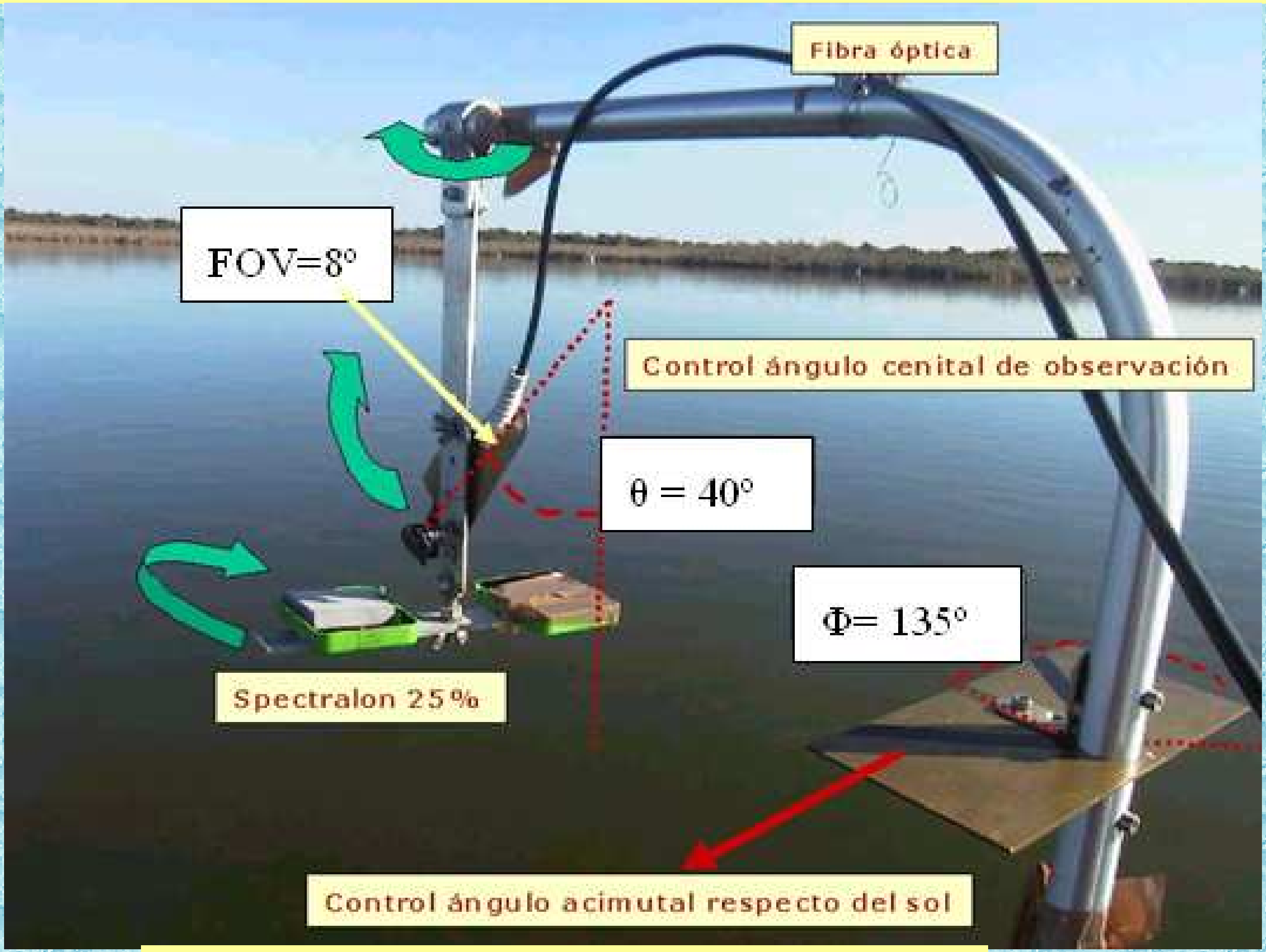
Coeficiente de atenuación vertical difusa incidente en el punto 5 de la laguna El Campillo (31 de julio de 2000).

3.- PROPIEDADES ÓPTICAS DEL AGUA



http://hercules.cedex.es/Ecosistemas/TeleCongresos/AEL%20pres%20GIGLM.pdf

Comportamiento de la Energía en el Agua



Protocolos NASA (Fargion & Muller 2000)

http://hercules.cedex.es/Ecosistemas/TeleCongresos/2wCHPa04.pdf

Comportamiento de la Energía en el Agua

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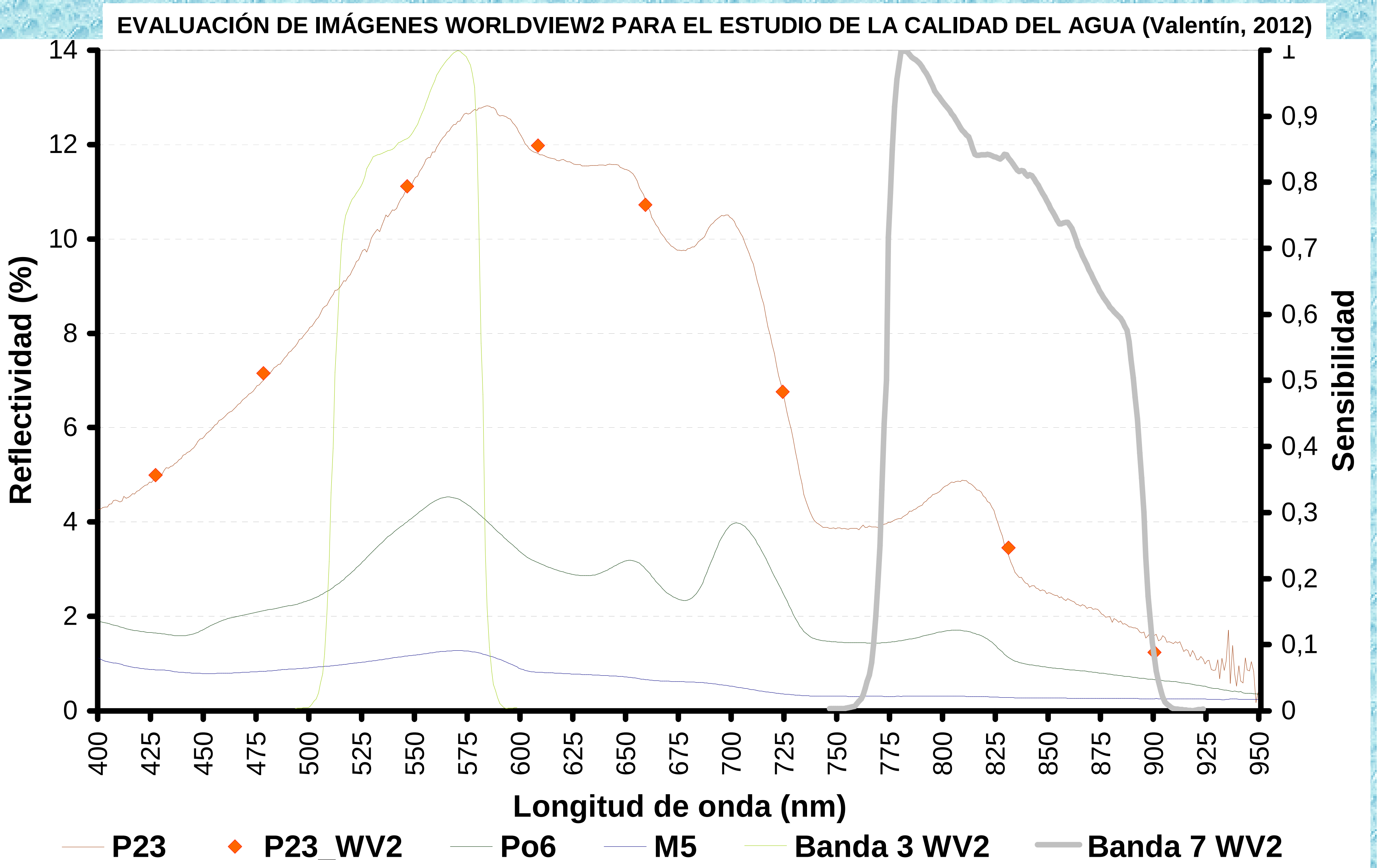
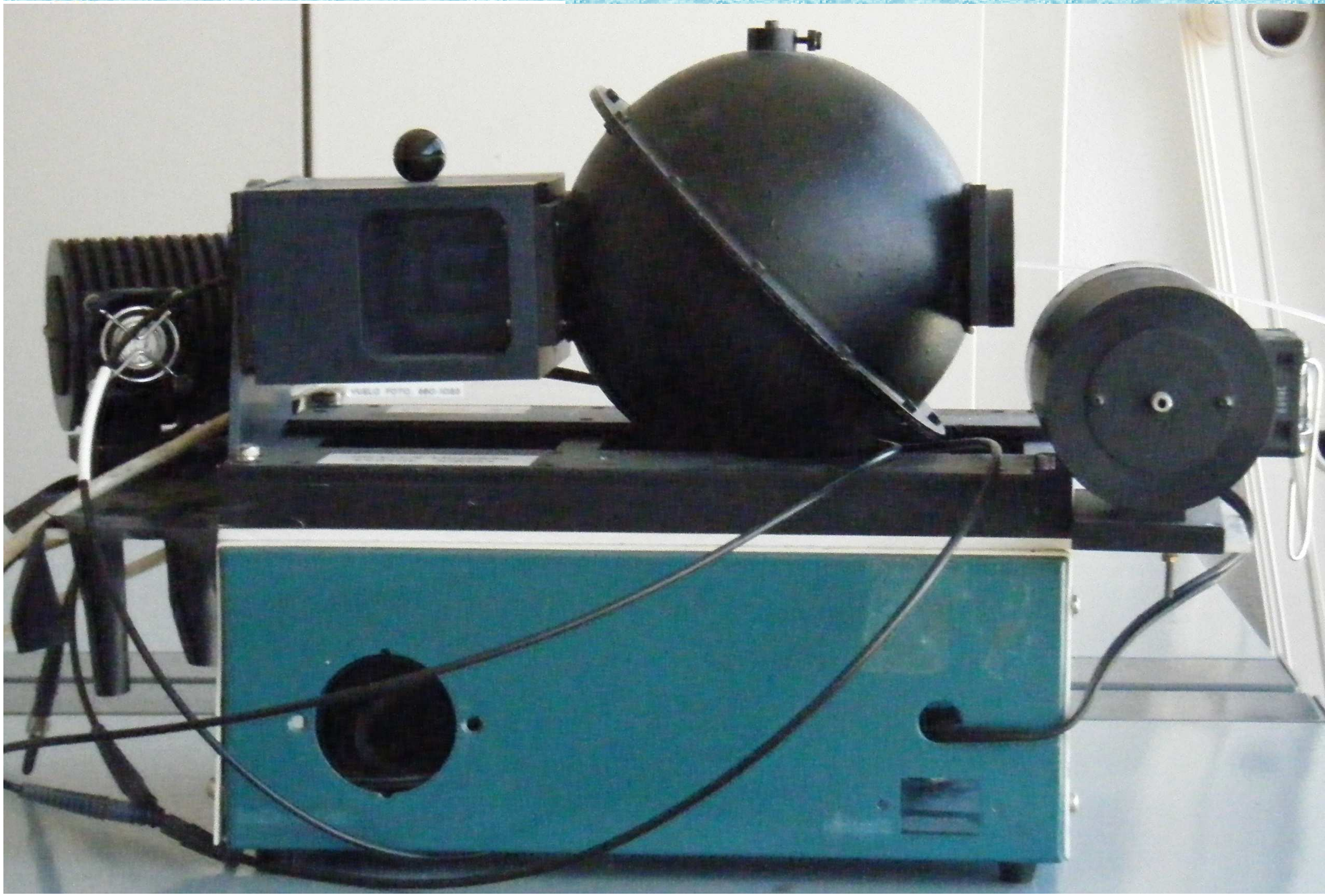


Propiedades Ópticas Inherentes a, b_b, c



Relación entre Propiedades Ópticas Inherentes y Aparentes

Modelo de Simulación de Monte Carlo

$K_d(z_m) = [a^2 + (0{,}47\mu_0 - 0{,}218)ab]^{1/2}/\mu_0$ (Kirk 1984)

$R(0^-, \lambda) = r_1 \, (b_b/b_b+a)$ (Gordon et al 1975)

$r_1(\mu_0) = -0{,}629\mu_0 + 0{,}975$ (Kirk 1984)

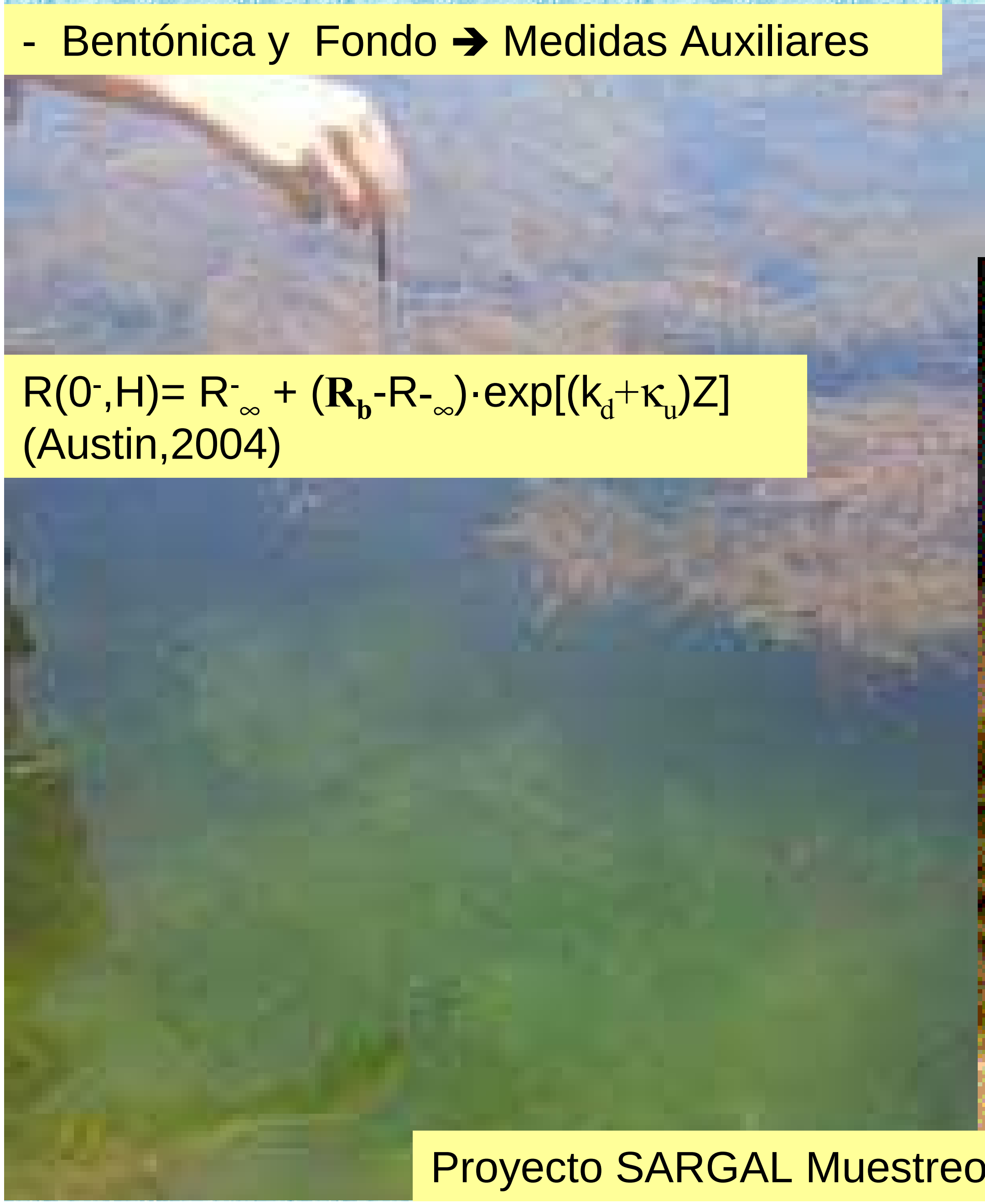
μ_0 es el coseno del ángulo cenital solar.

$R(0^+)/R(0^-)=0.544$

(Austin, 1980; Kirk, 1994; Kutser et al, 2006)

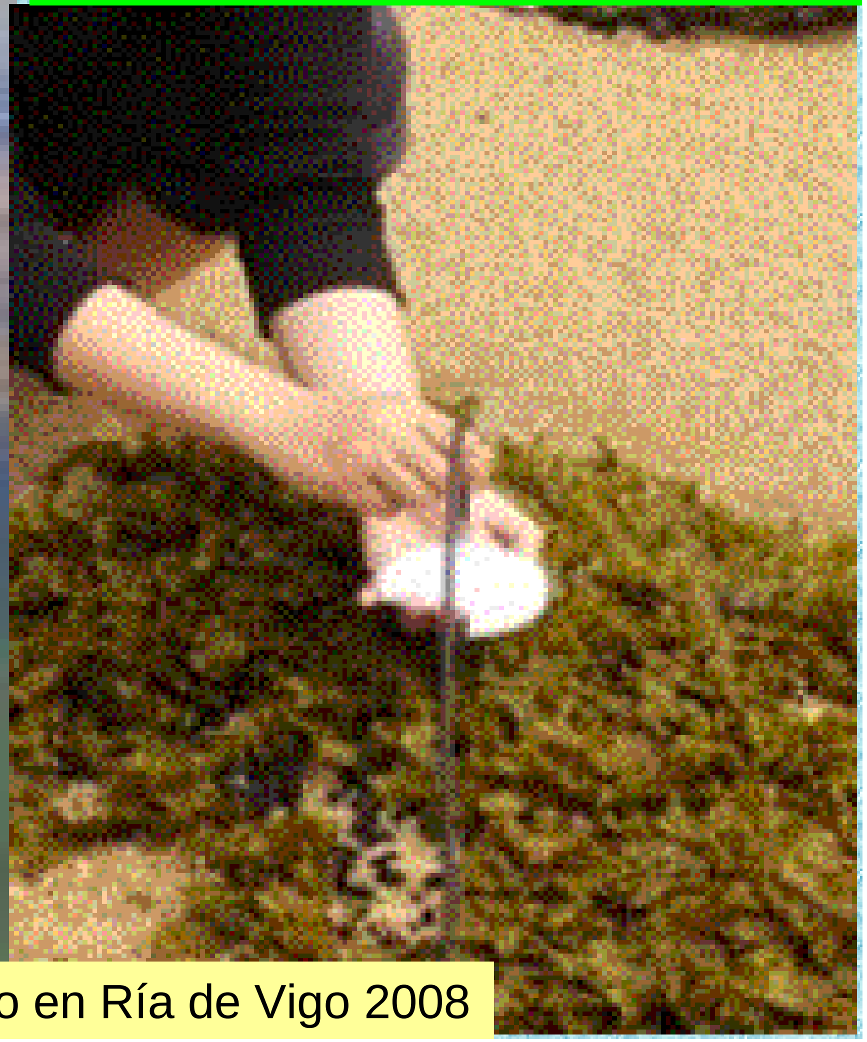
3.- PROPIEDADES ÓPTICAS DEL AGUA

- Bentónica y Fondo ➔ Medidas Auxiliares



$R(0^-,H)= R^-_{\infty} + (\mathbf{R_b}-R^-_{\infty})\cdot exp[(k_d+\kappa_u)Z]$
(Austin,2004)

MACROALGAS Y VEGETACIÓN BENTONICA



Proyecto SARGAL Muestreo en Ría de Vigo 2008

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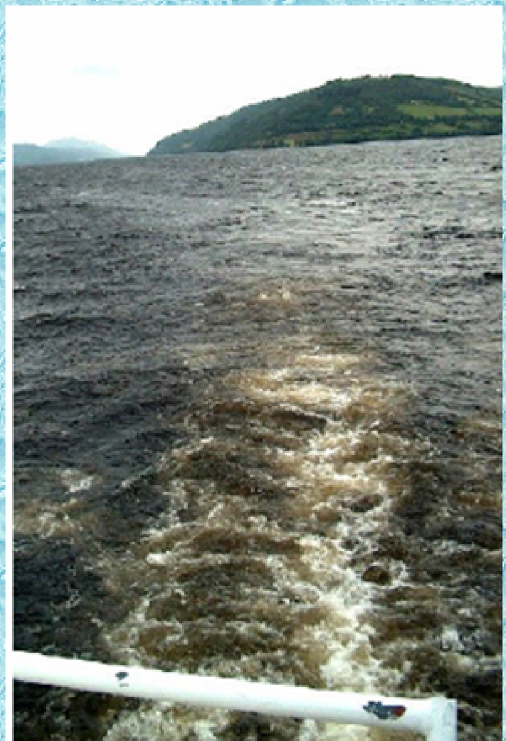
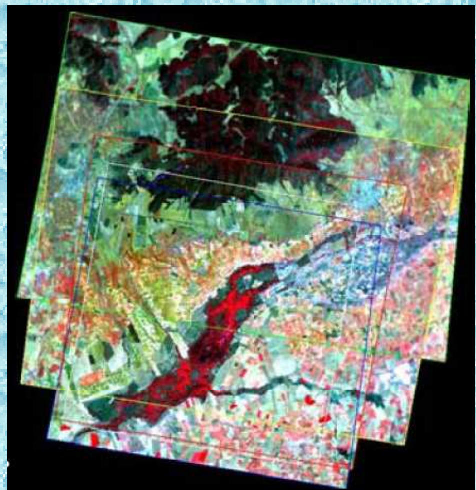
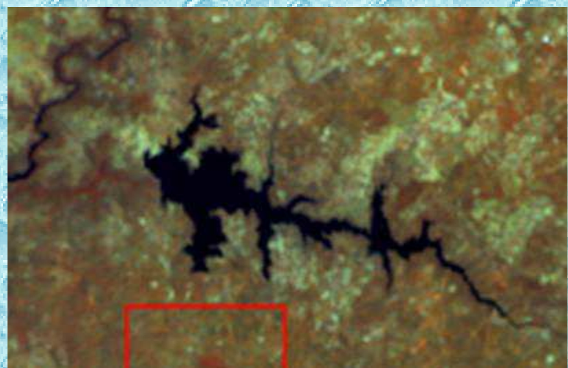
Lakes
Lagoons
Ponds



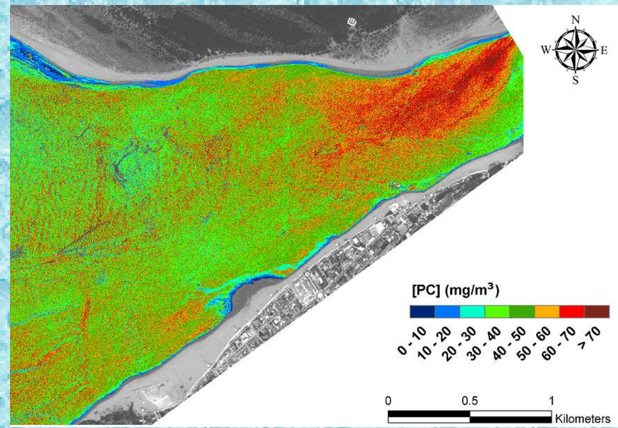
Wetlands



Reservoirs



Rivers

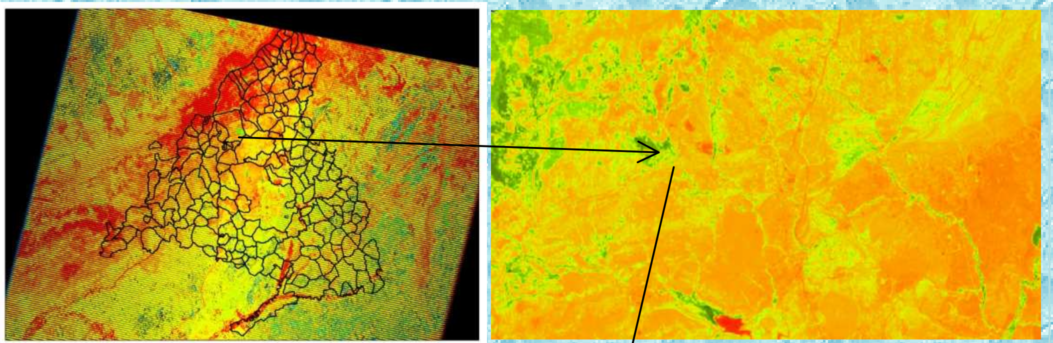


Coastal Areas

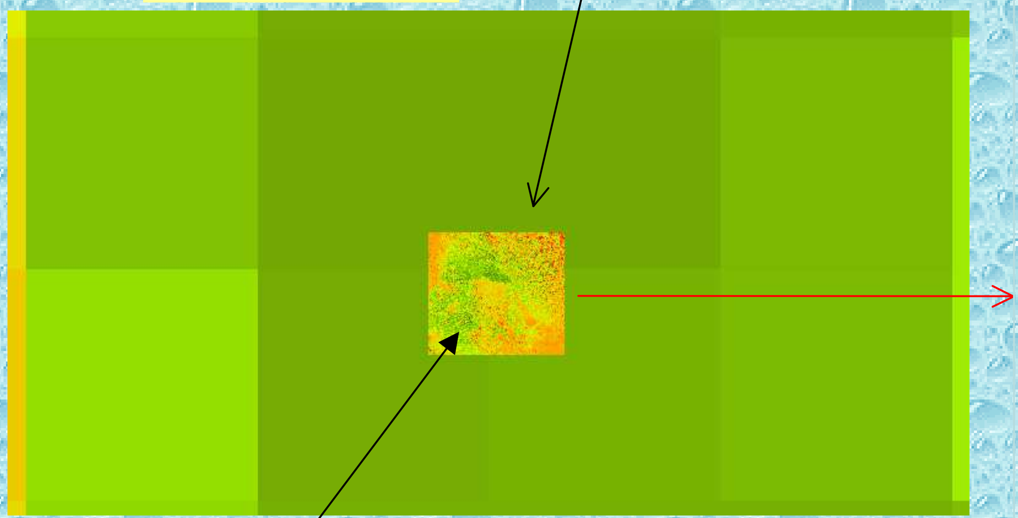
4.- TELEDETECCIÓN EN ECOSISTEMAS ACUÁTICOS

Benthic Cyanobacteria Thematic Mapper using Unmanned Aerial Vehicle (UAV)

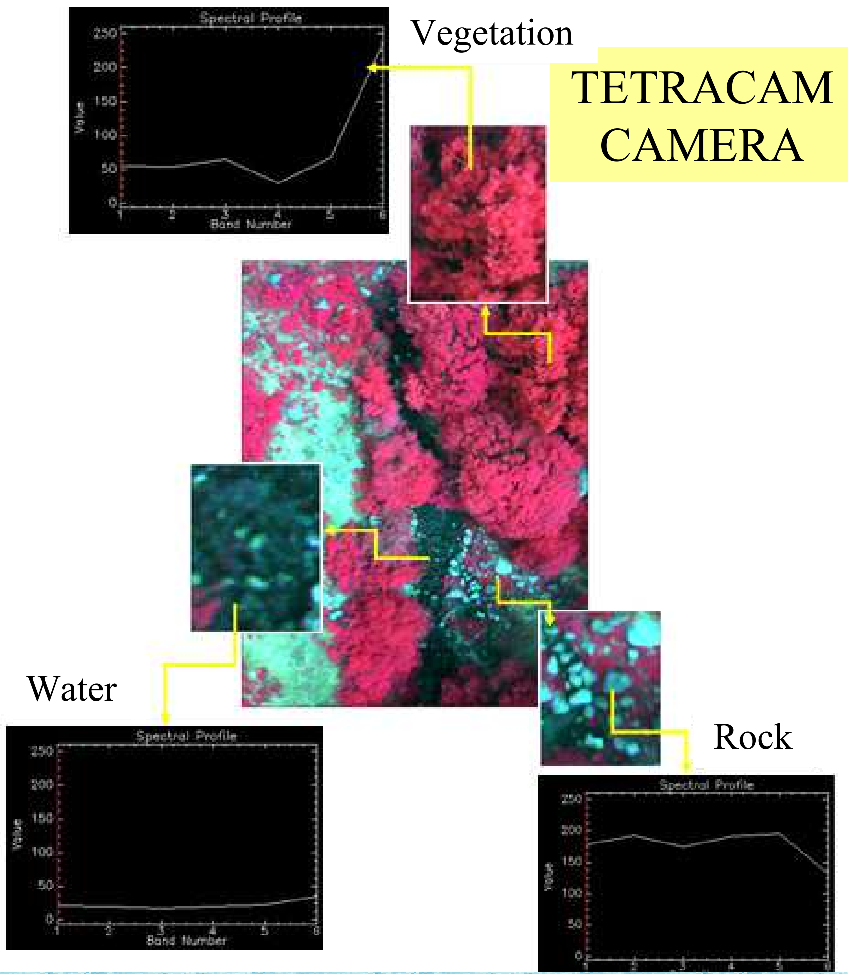
Paper on Draft



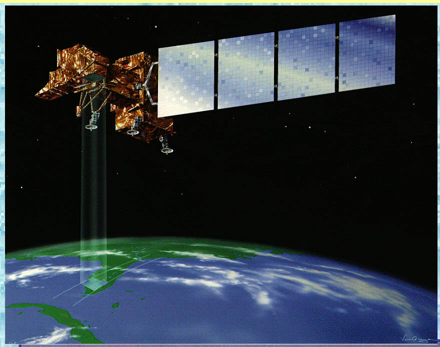
NDVI (LANDSAT 30 m)



NDVI (UAV 3 cm)



4.- TELEDETECCIÓN EN ECOSISTEMAS ACUÁTICOS



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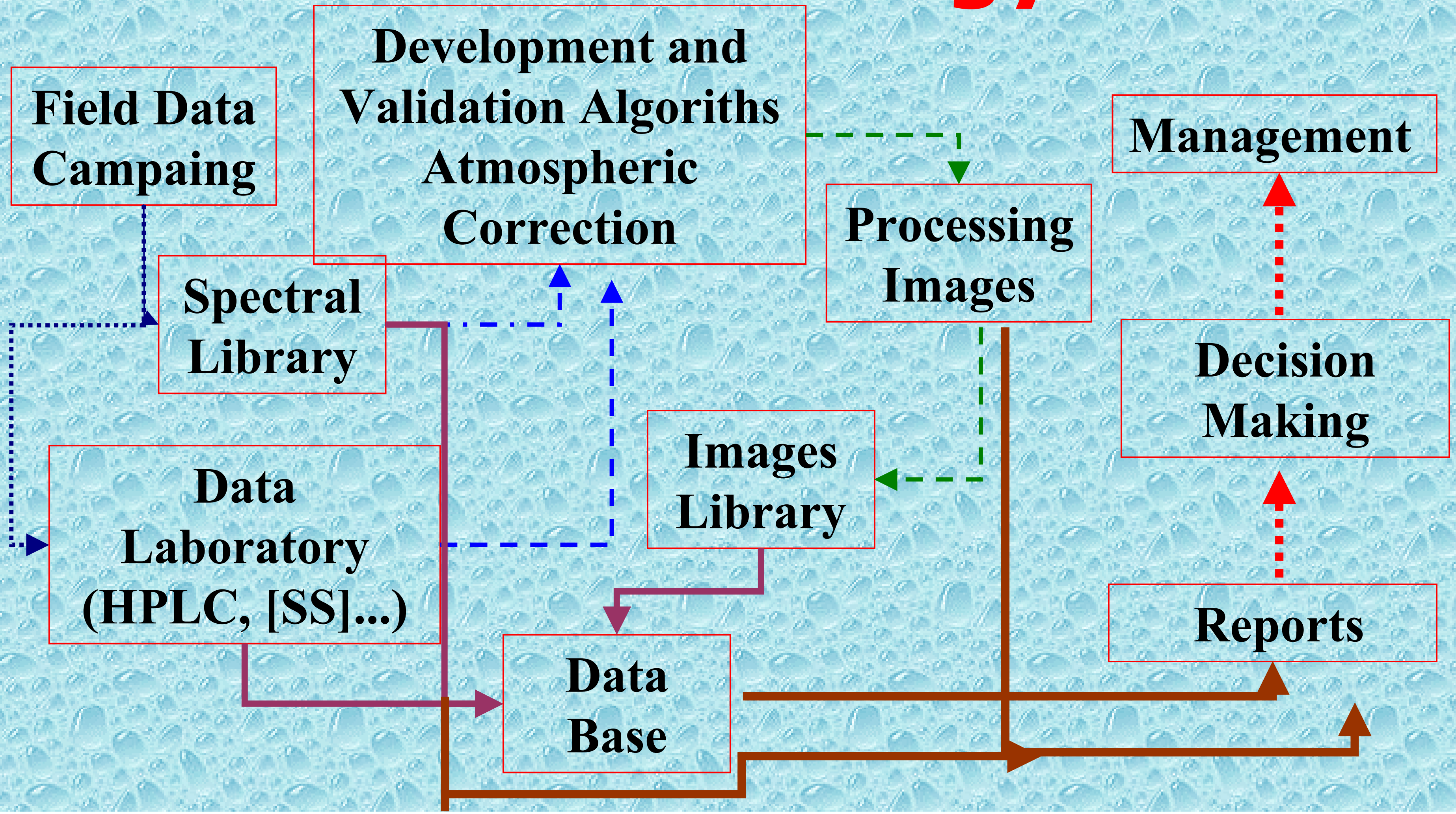
Metodology



4.- TELEDETECCIÓN EN ECOSISTEMAS ACUÁTICOS

¿Objetivo? ➔ Planificación

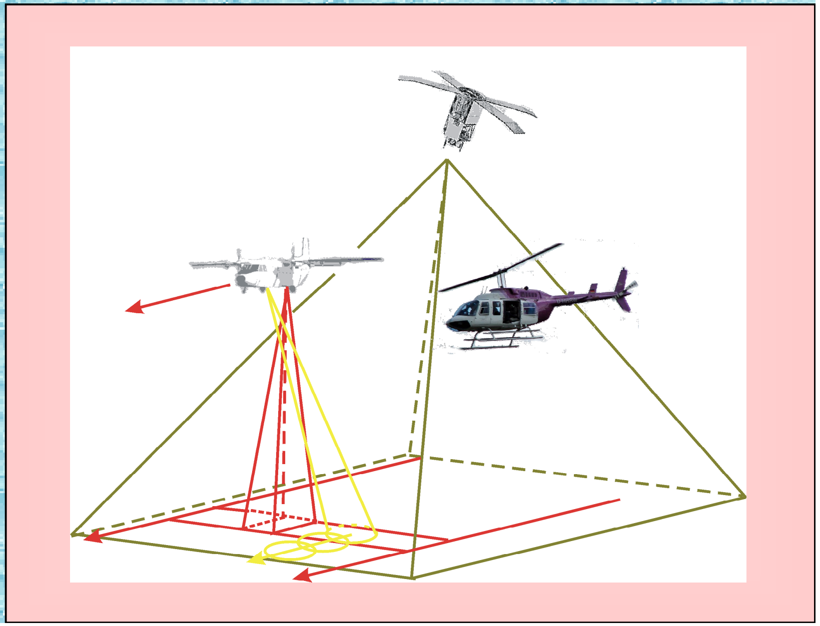
- Corrección Atmosférica ➔ ¿Sensor y Plataforma?

- Validación de Corrección Atmosférica ➔ ¿Sensor y Plataforma?

- Cartografía Temática

  - Bentónica y Fondo ➔ Medidas Auxiliares

  - Calidad de Agua ➔ Medidas Auxiliares



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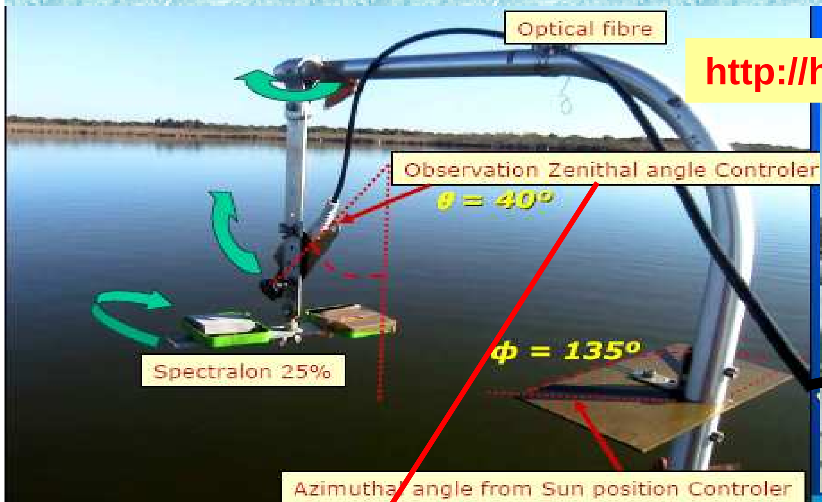
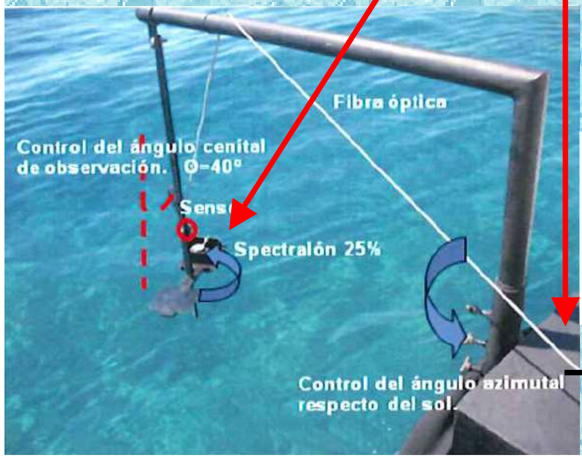
Field Data Campaing: Spectral Library.Reflectance

Protocolos NASA (Fargion & Muller 2000)

http://hercules.cedex.es/Ecosistemas/TeleCongresos/2wCHPa04.pdf



CEH-CEDEX Instruments



Environment Water Andalusian Agency (AMAYA) Instruments

http://www.aet.org.es/revistas/revista36/Numero36_07.pdf

Field Data Campaing: Spectral Library. Kd, Ku

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Field Data Campaing: Data Laboratory (HPLC, [SS]...)

http://hercules.cedex.es/Ecosistemas/Laboratorios.htm

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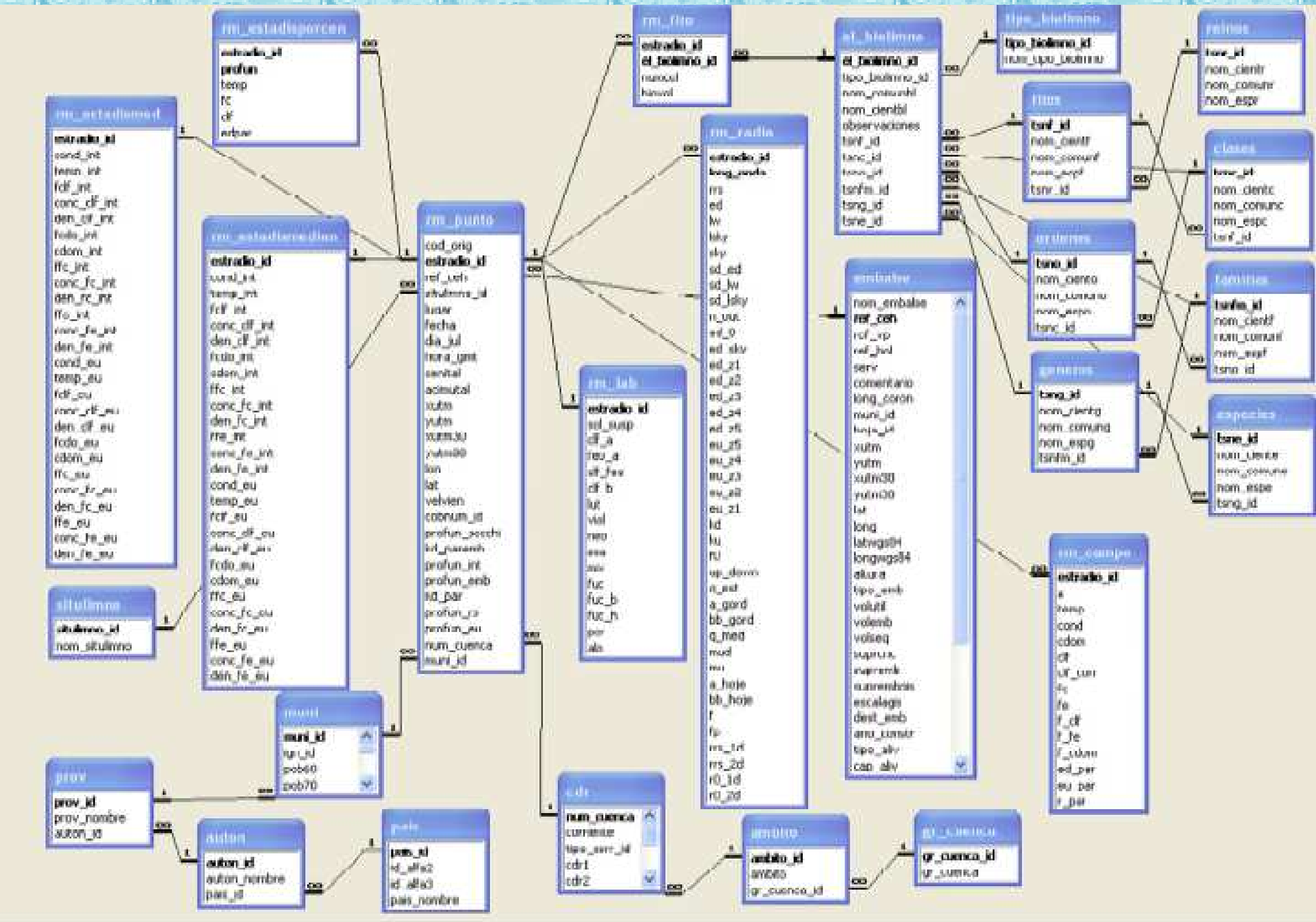
DATA BASE



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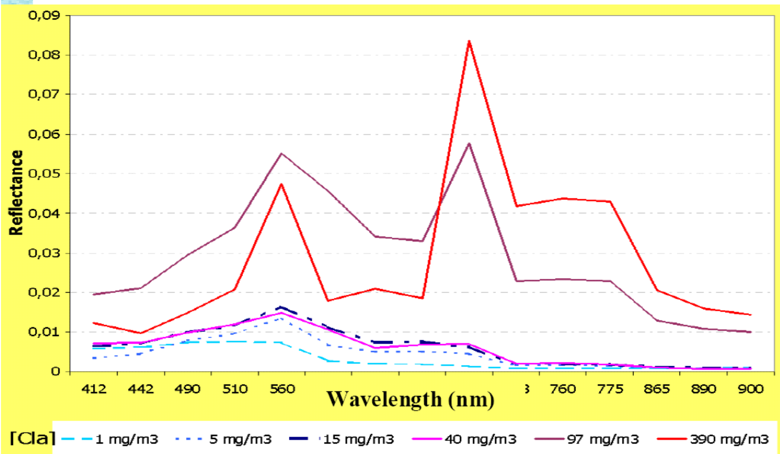
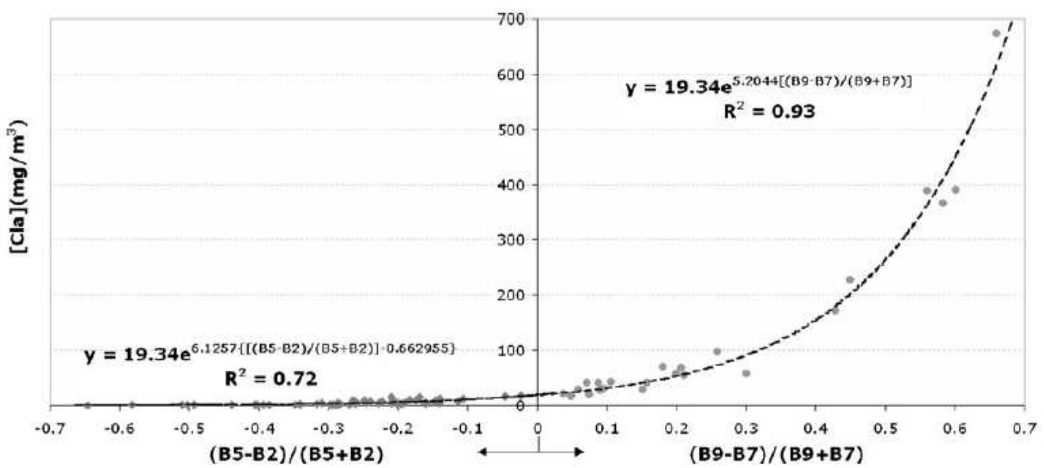
DEVELOPMENT AND VALIDATION ALGORITHMS

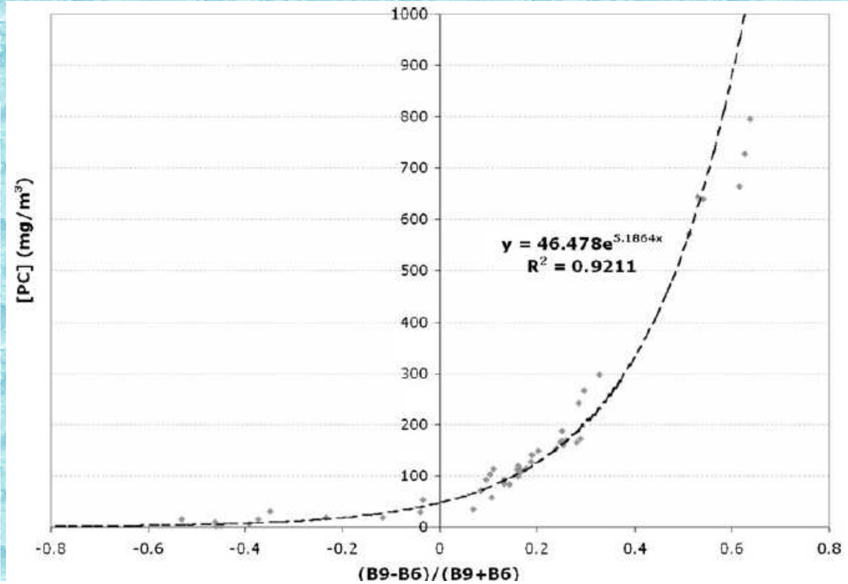
MERIS Reflectance bands



Environ Monit Assess
DOI 10.1007/s10661-010-1831-7

Remote sensing as a tool for monitoring water quality parameters for Mediterranean Lakes of European Union water framework directive (WFD) and as a system of surveillance of cyanobacterial harmful algae blooms (SCyanoHABs)





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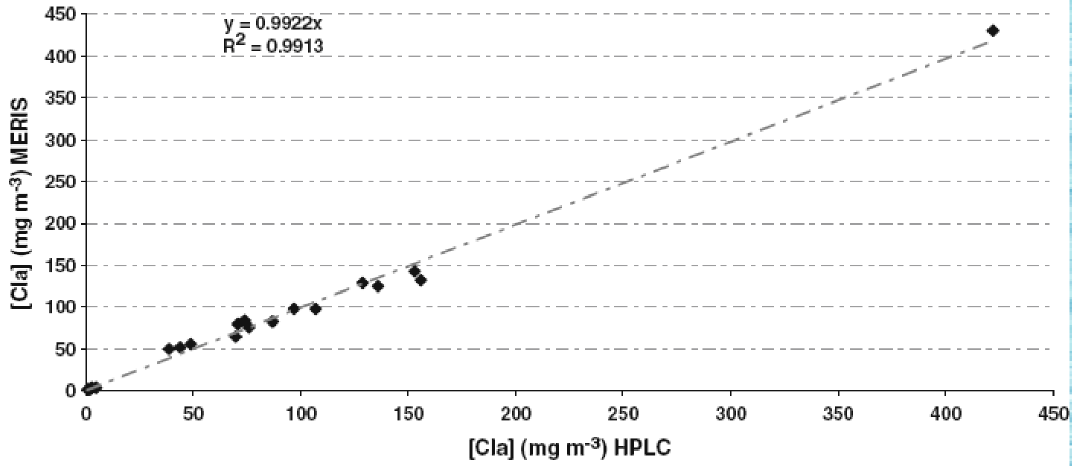
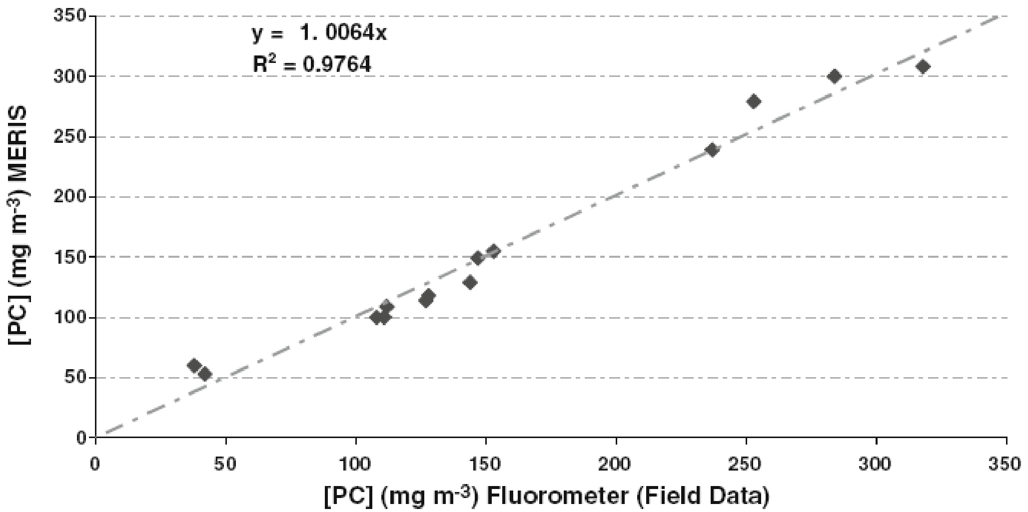
DEVELOPMENT AND VALIDATION ALGORITHMS



Comparison of chlorophyll-a HPLC (Field Data) and chlorophyll-a MERIS imagery ($n = 19$, $p < 0.001$)

Comparison of [PC] fluorometer measurements (Field Data) and [PC] MERIS imagery ($n = 14$, $p < 0.001$)



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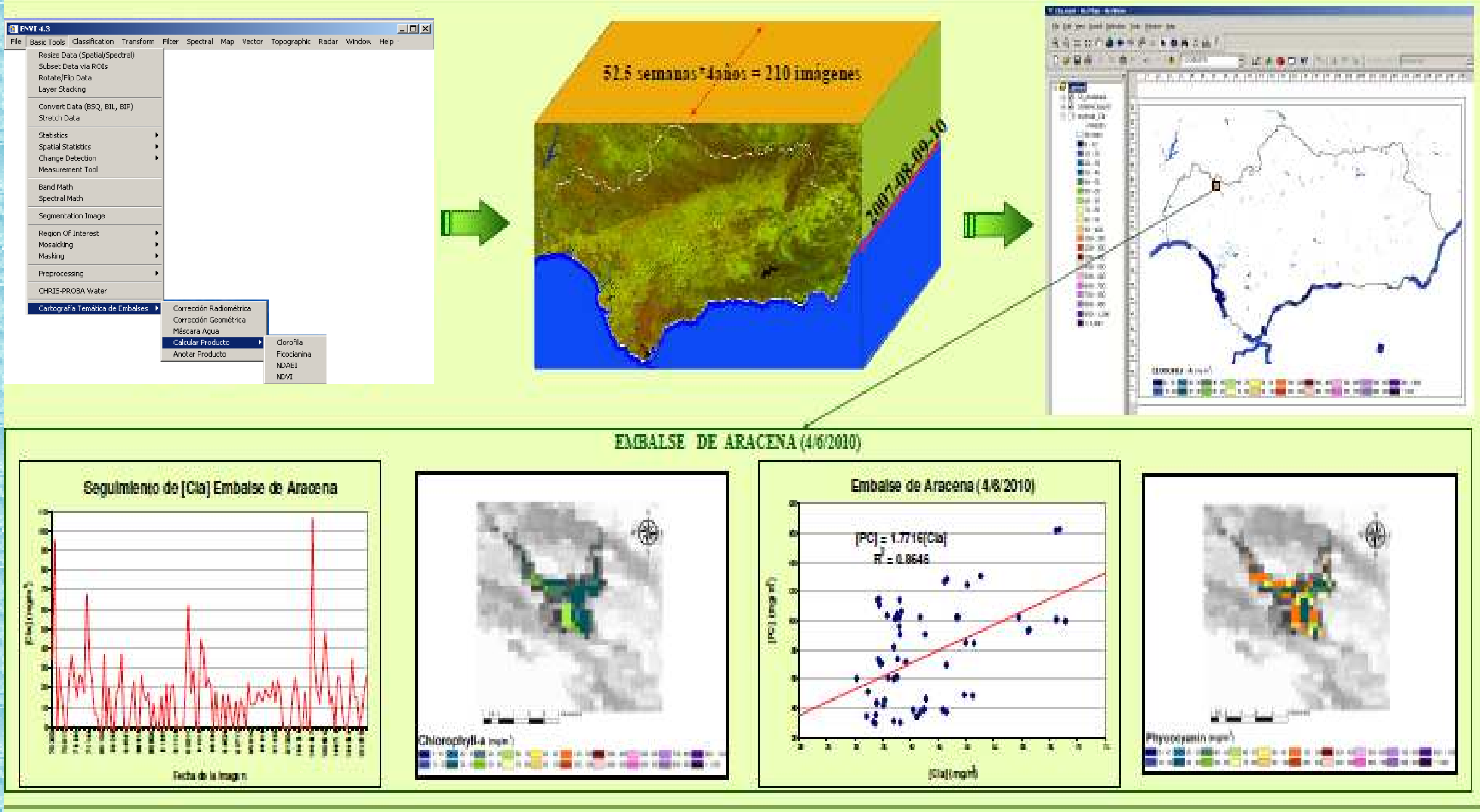
PROCESSING IMAGES

2º Congreso Ibérico de Cianotoxinas

IV Reunión de la Red de Estudios en Cianotoxinas

Sevilla 7 y 8 de Julio de 2011

PROCESAMIENTO DE IMÁGENES MERIS: 2007 - 2010



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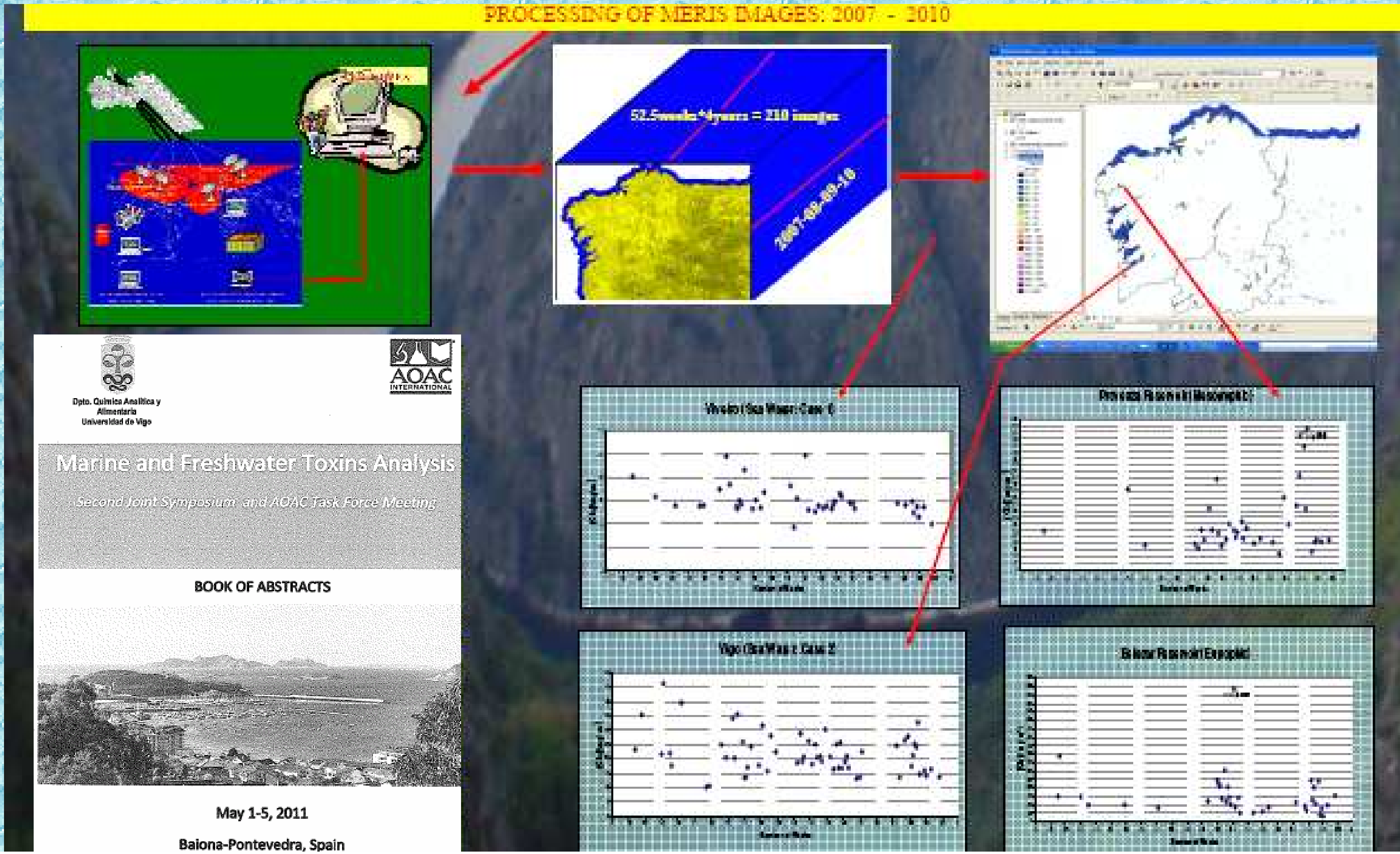
PROCESSING IMAGES



Remote Sensing as a tool for the management of Spanish Aquatic Ecosystems

RESULTS: RESERVOIRS

UNIVERSIDAD AUTONOMA DE MADRID
GOBIERNO DE ESPAÑA
MINISTERIO DE FOMENTO
MINISTERIO DE MEDIO AMBIENTE Y MEDIO RURAL Y MARINO
CEDEX CENTRO DE ESTUDIOS Y EXPERIMENTACIÓN DE OBRAS PÚBLICAS

"Monitoring by remote sensing the ecological state of different Spanish inland water bodies through the mapping of photosynthetic pigments characteristics of cyanobacteria"

European Master of Inland Water Quality Assessment
Master Thesis 2008/2009
CLARA ARANCÓN ALONSO

Professional tutor: Jose Antonio Domínguez Gómez
Academic tutor: Antonio Quesada de Corral

http://hercules.cedex.es/Ecosistemas/09Dic.pdf

Remote Sensing as a tool for the management of Spanish Aquatic Ecosystems

RESULTS: RESERVOIRS

OECD trophic classification and "Expanded OECD trophic classification"

TROPHIC STATE (OCDE CLASSIFICATION)	
	Chl-a (mg/m3)
Ultraoligotrophic	< 1
Oligotrophic	1-2,5
Mesotrophic	2,5-7,9
Eutrophic	8-25
Hypereutrophic	> 25

EXPANDED OECD TROPHIC CLASSIFICATION	
	Suggested boundaries Chl-a (mg/m3)
Ultraoligotrophic	< 1
Oligotrophic	1-2,5
Mesotrophic	2,5-7,9
Eutrophic	8-25
Hypereutrophic-1	25,1-50
Hypereutrophic-2	50-100
Hypereutrophic-3	100,1-200
Hypereutrophic-4	> 200

http://hercules.cedex.es/Ecosistemas/09Dic.pdf

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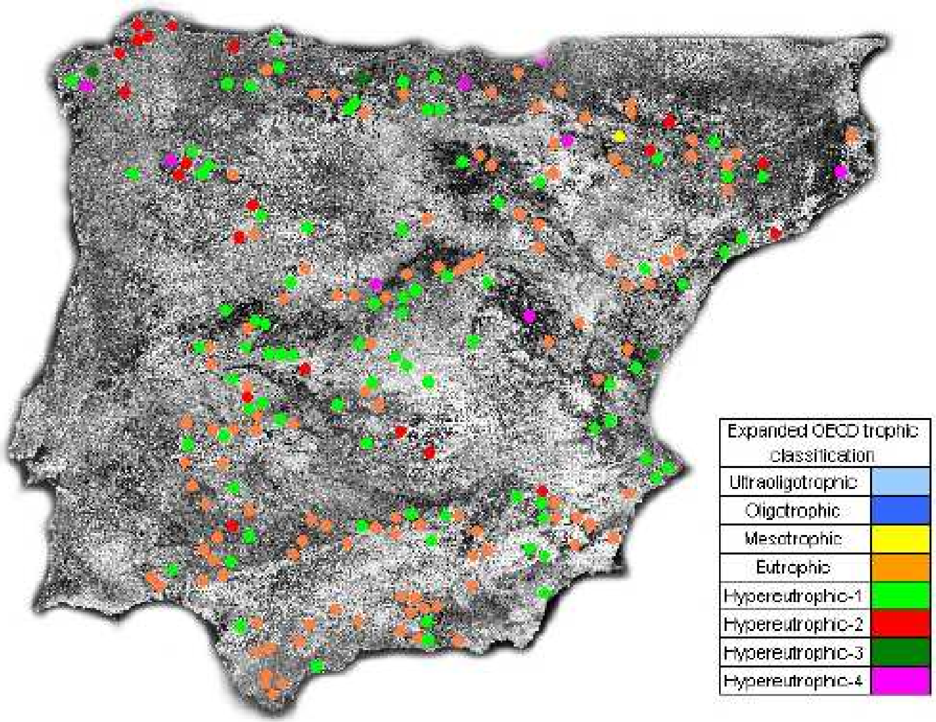
NATURAL ENVIRONMENT RESEARCH COUNCIL

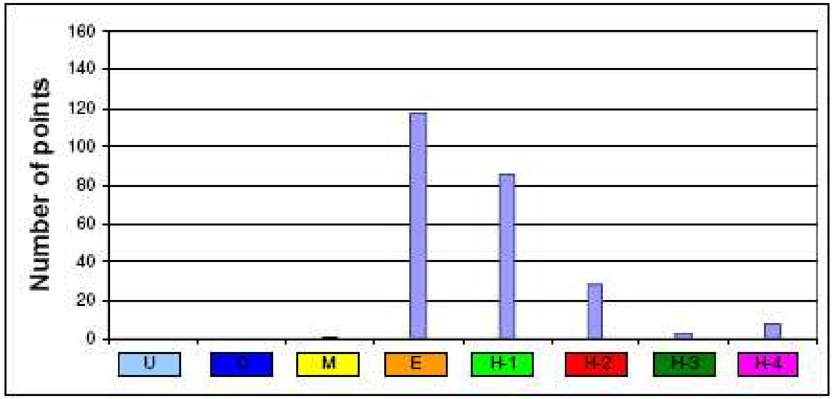
Remote Sensing as a tool for the management of Spanish Aquatic Ecosystems

RESULTS: RESERVOIRS

Distribution map of the Trophic state found at each water body

http://hercules.cedex.es/Ecosistemas/09Dic.pdf



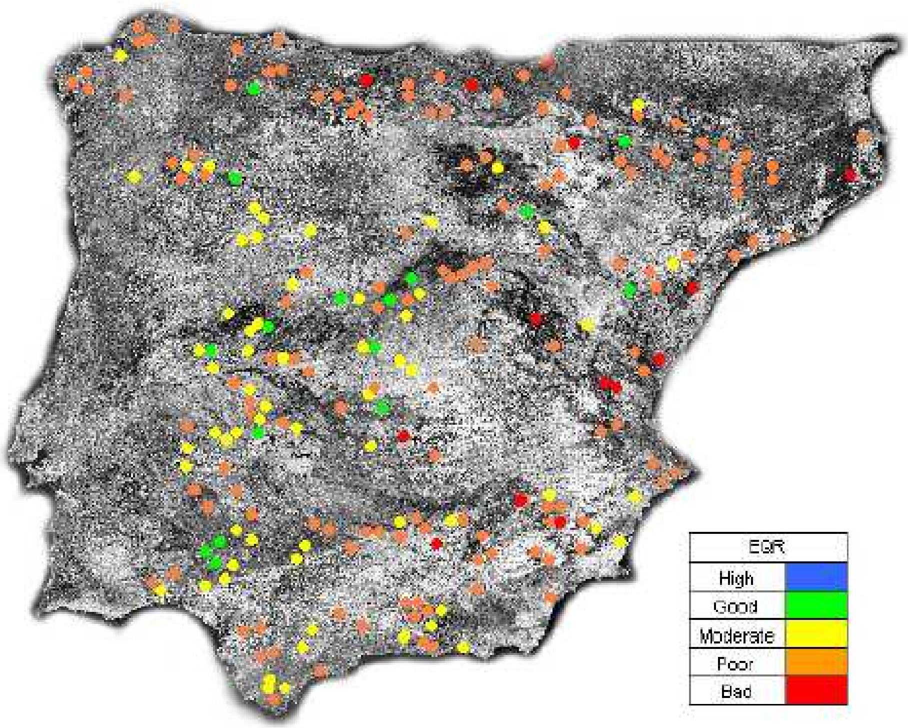


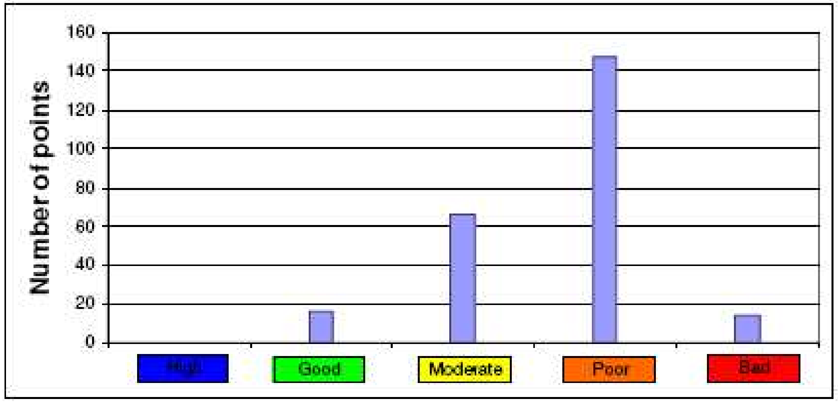
Remote Sensing as a tool for the management of Spanish Aquatic Ecosystems

RESULTS: RESERVOIRS

Distribution map of the EQR found at each water body

http://hercules.cedex.es/Ecosistemas/09Dic.pdf





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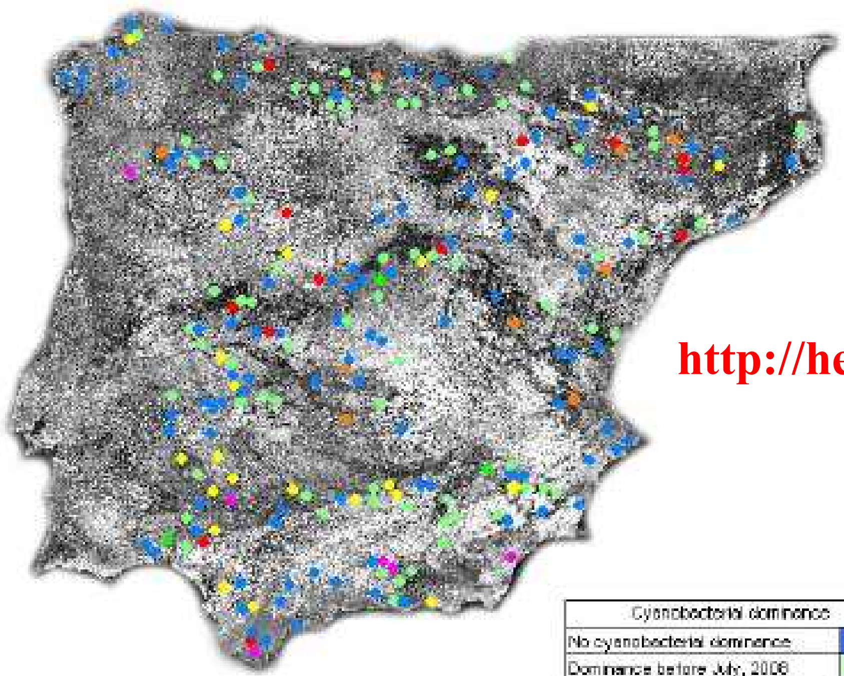
Remote Sensing as a tool for the management of Spanish Aquatic Ecosystems

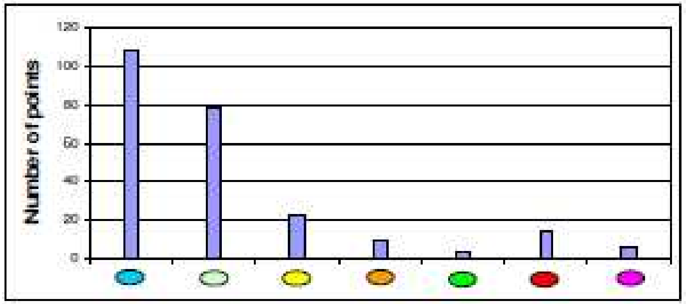
RESULTS: RESERVOIRS

Distribution map of the Cyanobacterial dominance found at each water body



http://hercules.cedex.es/Ecosistemas/09Dic.pdf

Cyanobacterial dominance	
No cyanobacterial dominance	blue
Dominance before July, 2008	light green
Dominance during July, 2008	yellow
Dominance during August, 2008	orange
Dominance during September, 2008	green
Dominance during October, 2008	red
Dominance after October, 2008	magenta



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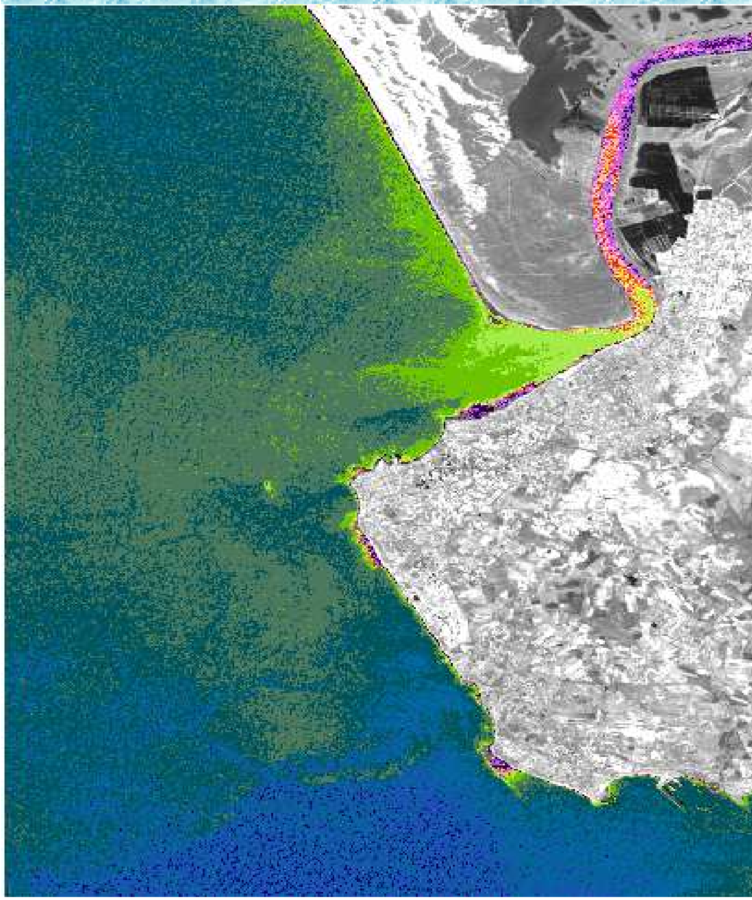
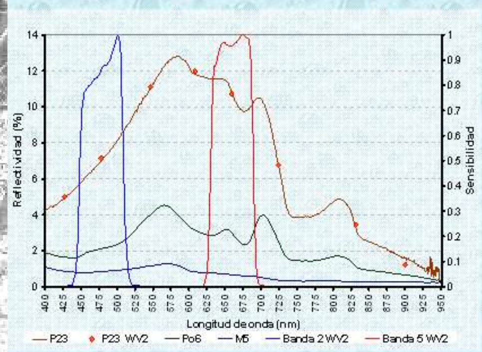
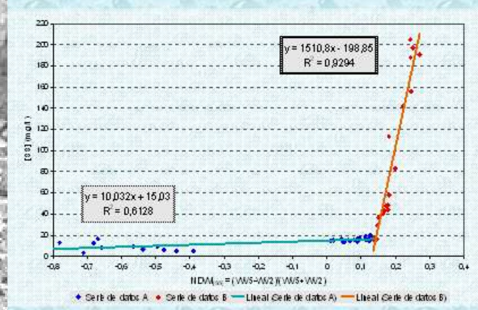
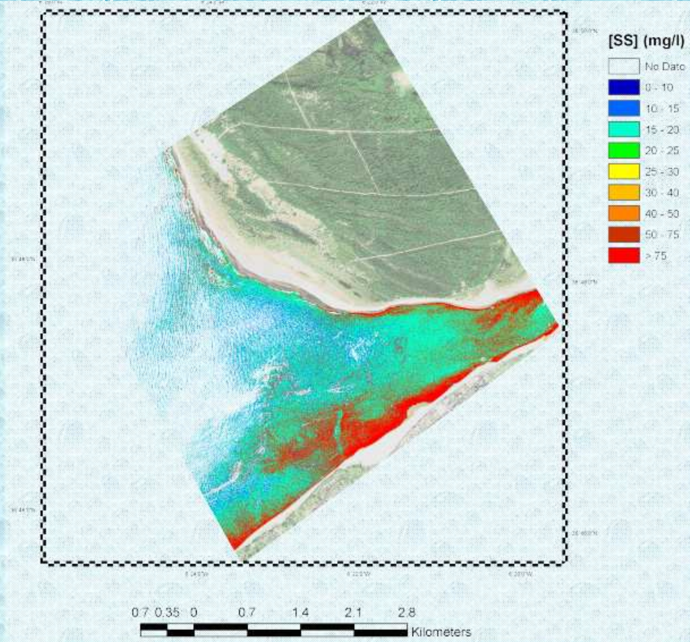
RESULTS: RIVERS

MONITORING GUADALQUIVIR RIVER: LANDSAT and WORD VIEW 2



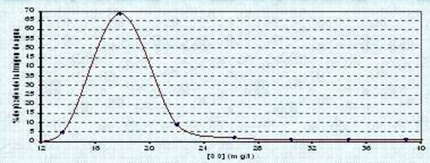






[SS] (mg/l) = 10,032 $NDWI_{SS}$ + 15,03

[SS] (mg/l) = 1510,8 $NDWI_{SS}$ - 198,85



Remote Sensing as a tool for the management of Spanish Aquatic Ecosystems

RESULTS: WETLANDS

IGARSS 2008 BOSTON
2008 IEEE International Geoscience & Remote Sensing Symposium
July 6-11, 2008 | Boston, Massachusetts, U.S.A.

http://hercules.cedex.es/Ecosistemas/IGARSS2008.pdf

APPLYING MULTI-ANGLE HYPERSPECTRAL DATA TO DETECT HUMAN-INDUCED CHANGES CAUSING WETLAND DEGRADATION IN SEMI-ARID AREAS (NATIONAL PARK LAS TABLAS DE DAIMIEL, SPAIN)

Thomas Schmid[1], José Antonio Domínguez[2], Jesús Solana[3], José Gumuzzio[3] and Magaly Koch[4]

[1]CIEMAT, Av. Complutense 22, 28040, Madrid, Spain.
[2]Center for Hidrographic Studies CEDEX, Paseo Bajo de la Virgen del Puerto, 3, 28005 Madrid, Spain.
[3]Autonomous University of Madrid, Science Faculty, Madrid, Spain.
[4]Centre for Remote Sensing, Boston University, Boston, MA, USA.
thomas.schmid@ciemat.es

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Remote Sensing as a tool for the management of Spanish Aquatic Ecosystems

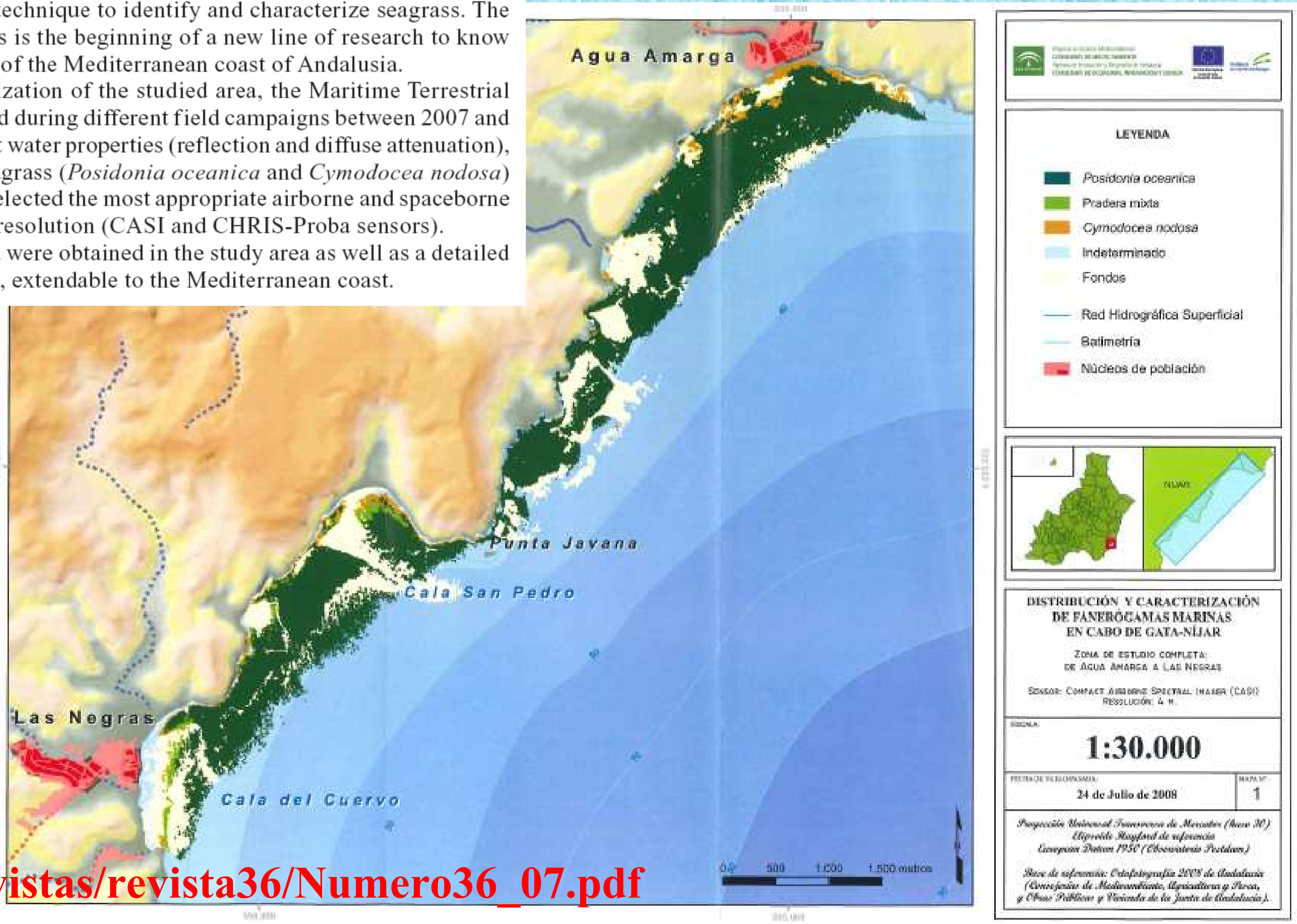
RESULTS: COASTAL AREAS

Development of a methodology for the characterization of seagrass on the andalusian coast using remote sensing techniques with hiperspectral sensors

Remote sensing is considered a non-invasive technique to identify and characterize seagrass. The evaluation of the use of images and their analysis is the beginning of a new line of research to know the best way for mapping the ma-rine ecosystem of the Mediterranean coast of Andalusia.

The biophysical and environmental characterization of the studied area, the Maritime Terrestrial Natural Park of Cabo de Gata-Nijar was conducted during different field campaigns between 2007 and 2009, with the objective of measuring the apparent water properties (reflection and diffuse attenuation), the spectral response of the different types of seagrass (*Posidonia oceanica* and *Cymodocea nodosa*) and bottom substrate types. From these data, we selected the most appropriate airborne and spaceborne sensors for the study and its spectral and spatial resolution (CASI and CHRIS-Proba sensors).

As a result of this research, maps of the seabed were obtained in the study area as well as a detailed methodology for the characterization of seagrass, extendable to the Mediterranean coast.



http://www.aet.org.es/revistas/revista36/Numero36_07.pdf

4.- TELEDETECCIÓN EN ECOSISTEMAS ACUÁTICOS

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RESULTS: COASTAL AREAS

Mar Biol
DOI 10.1007/s00227-012-1987-5

ORIGINAL PAPER

Assessment of AHS (Airborne Hyperspectral Scanner) sensor to map macroalgal communities on the Ría de vigo and Ría de Aldán coast (NW Spain)

G. Casal · N. Sánchez-Carnero · J. A. Domínguez-Gómez · T. Kutser · J. Freire

Received: 30 August 2011 / Accepted: 19 June 2012

Abstract Ría de Vigo and Ría de Aldán have high biological richness that is reflected in the number of environmental protection areas like the Atlantic Islands National Park and five places of community interest. Benthic algal communities play an important role in these ecosystems due to their ecological functions and support a great part of this biological richness. We tested by means of bio-optical modelling and Airborne Hyperspectral Scanner (AHS) images to what extent remote sensing could be used to map these communities in Ría de Vigo and Ría de Aldán (NW Spain). Reflectance spectra of dominating macroalgae groups were modelled for different water depths in order to estimate the separability of different bottom types based on their spectral signatures and the spectral characteristics of the AHS. Our results indicate that separation between three macroalgae groups (green, brown and red) as well as sand is possible when the bottoms are emerged during low tide. The spectra differences decrease rapidly with increasing water depth. Two types of classifications were carried out with the three AHS images: maximum likelihood and spectral angle mapper (SAM). Maximum likelihood showed positive results reaching overall accuracy percentages higher than 95 % and kappa coefficients higher than 0.90 for the bottom classes: *shallow sand, deep sand, emerged rock, emerged macroalgae* and *submerged macroalgae*. Sand and algae substrates were then separately analysed with SAM. These classifications showed positive results for differentiation between green and brown macroalgae until 5 m depth and high differences between all macroalgae and sandy substrate. However, differences between red and brown macroalgae are only detectable when the algae are emerged.

Introduction

Benthic algal communities play an important role in coastal ecosystems due to their ecological functions. These communities are essential for many organisms as habitat (e.g. Cacabelos et al. 2010), mating and nursery grounds (e.g. Shaffer 2003), feeding areas (e.g. Lorentsen et al. 2004) and refuge (e.g. Gotceitas et al. 1997). Another relevant aspect is their important contribution to primary production

Estuarine, Coastal and Shelf Science 94 (2011) 281–290

Contents lists available at ScienceDirect

Estuarine, Coastal and Shelf Science

journal homepage: www.elsevier.com/locate/ecss

ELSEVIER

Mapping benthic macroalgal communities in the coastal zone using CHRIS-PROBA mode 2 images

G. Casal [a,*], T. Kutser [b], J.A. Domínguez-Gómez [c], N. Sánchez-Carnero [a], J. Freire [a]

[a] Grupo de Recursos Marinos y Pesquerías, Facultad de Ciencias, Universidad de A Coruña, Rúa da Fraga 10, 15008 A Coruña, Spain
[b] Estonian Marine Institute, University of Tartu, Mäealuse 14, Tallinn 12618, Estonia
[c] Centro de Estudios Hidrográficos (CEDEX), Paseo Bajo de la Virgen del Puerto 3, 28005 Madrid, Spain

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REPORTS & PAPERS

http://hercules.cedex.es/Ecosistemas/teledeteccion.htm

5.-CONTAMINACIÓN DE AGUAS MEDIANTE TELEDETECCIÓN

22.12.2000 | ES | Diario Oficial de las Comunidades Europeas | L 327/1

I

(Actos cuya publicación es una condición para su aplicabilidad)

DIRECTIVA 2000/60/CE DEL PARLAMENTO EUROPEO Y DEL CONSEJO

de 23 de octubre de 2000

por la que se establece un marco comunitario de actuación en el ámbito de la política de aguas

https://www.boe.es/doue/2000/327/L00001-00073.pdf

5.-CONTAMINACIÓN DE AGUAS MEDIANTE TELEDETECCIÓN

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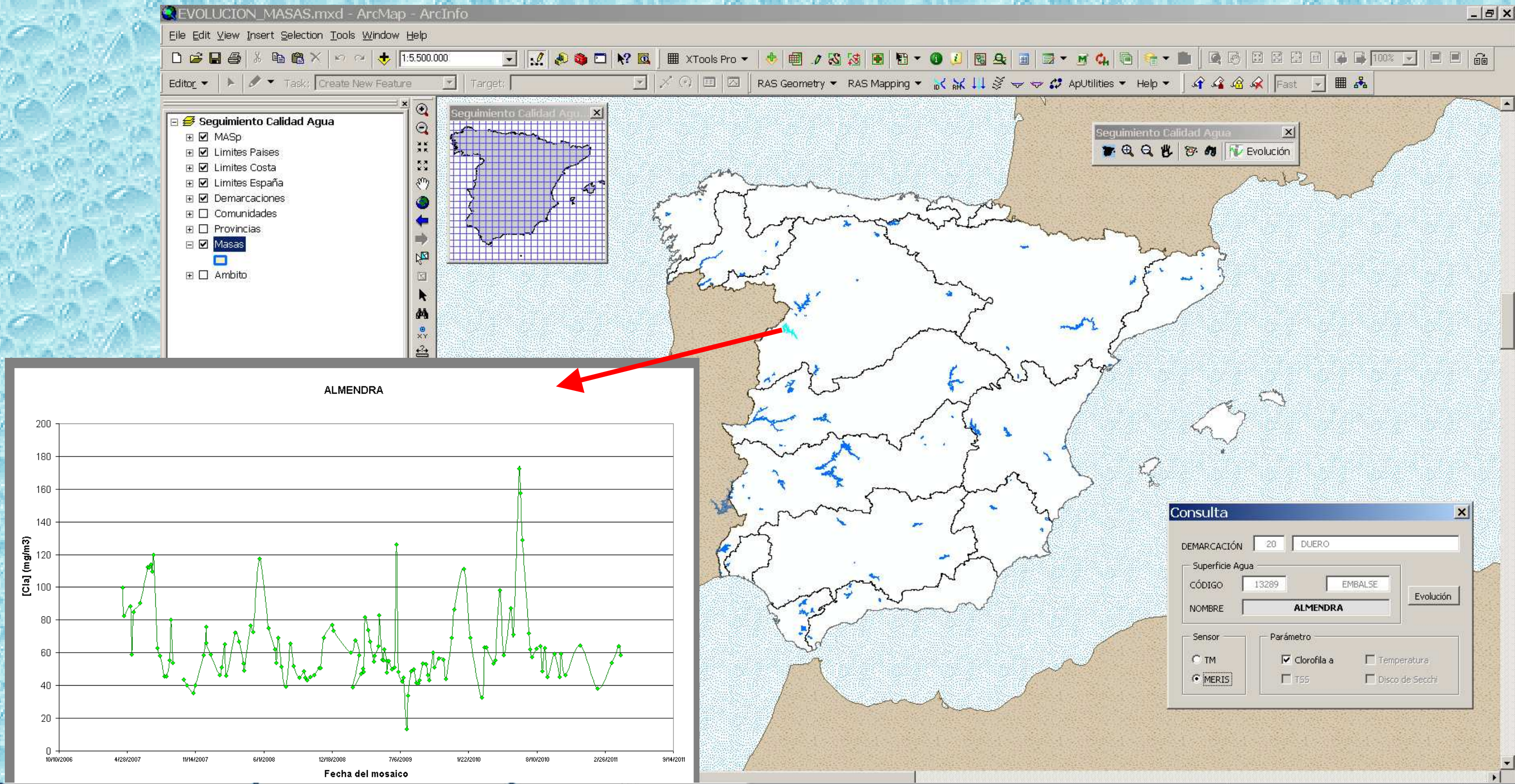
Remote Sensing as a tool for the management of Spanish Aquatic Ecosystems

MANAGEMENT



MINISTERIO DE AGRICULTURA, ALIMENTACIÓN Y MEDIO AMBIENTE

SECRETARÍA DE ESTADO DE MEDIO AMBIENTE

DIRECCIÓN GENERAL DEL AGUA

ESTUDIO DE UTILIZACIÓN DE LA TELEDETECCIÓN COMO HERRAMIENTA DE IDENTIFICACIÓN, SEGUIMIENTO Y CONTROL DEL MEDIO HÍDRICO Y PROPUESTA DE NUEVAS APLICACIONES EN LA PLANIFICACIÓN HIDROLÓGICA.

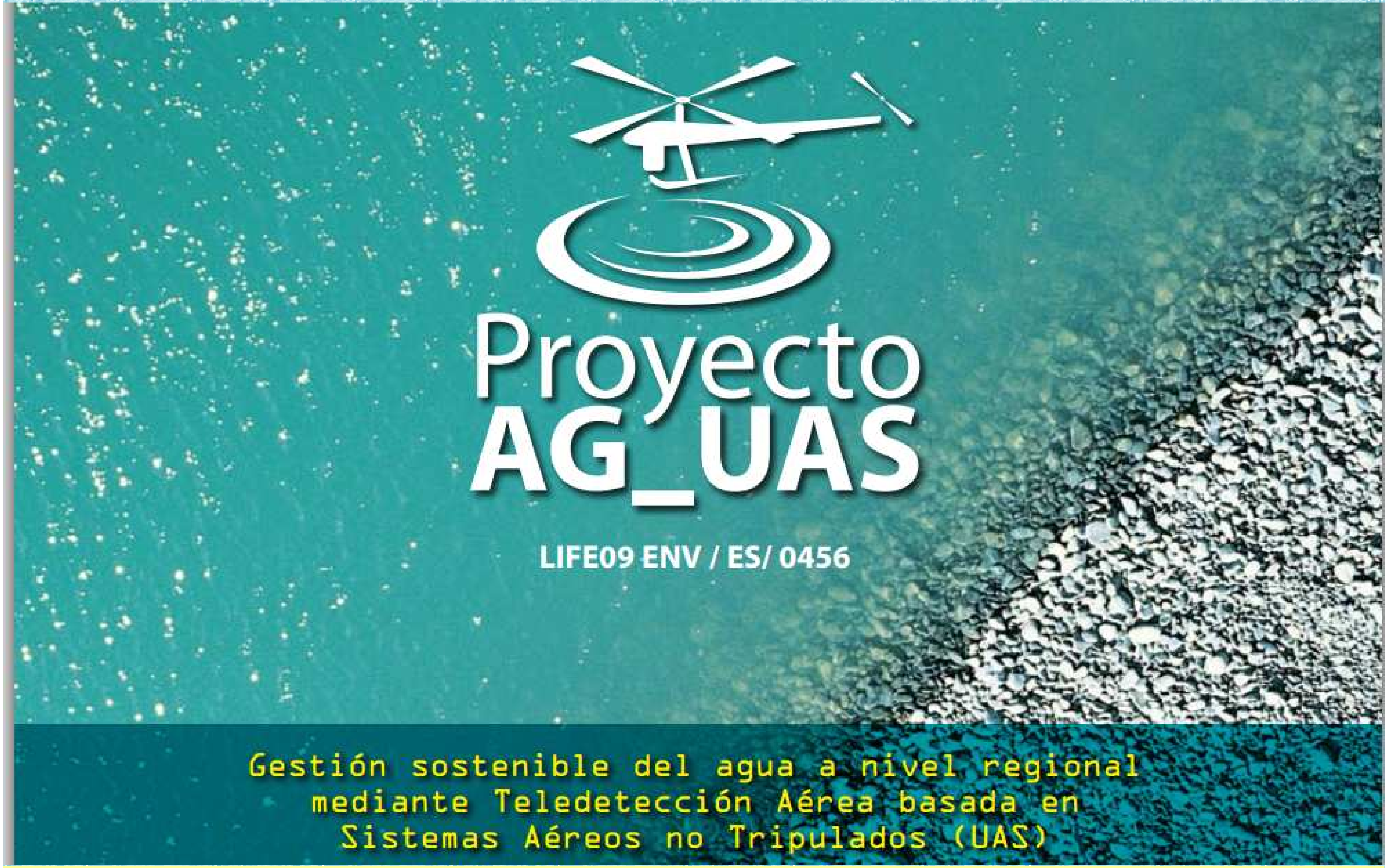
DIRECCIÓN

SUBDIRECCIÓN GENERAL DE PLANIFICACIÓN Y USO SOSTENIBLE DEL AGUA

CONSULTOR:

AMBISAT INGENIERÍA AMBIENTAL

5.-CONTAMINACIÓN DE AGUAS MEDIANTE TELEDETECCIÓN



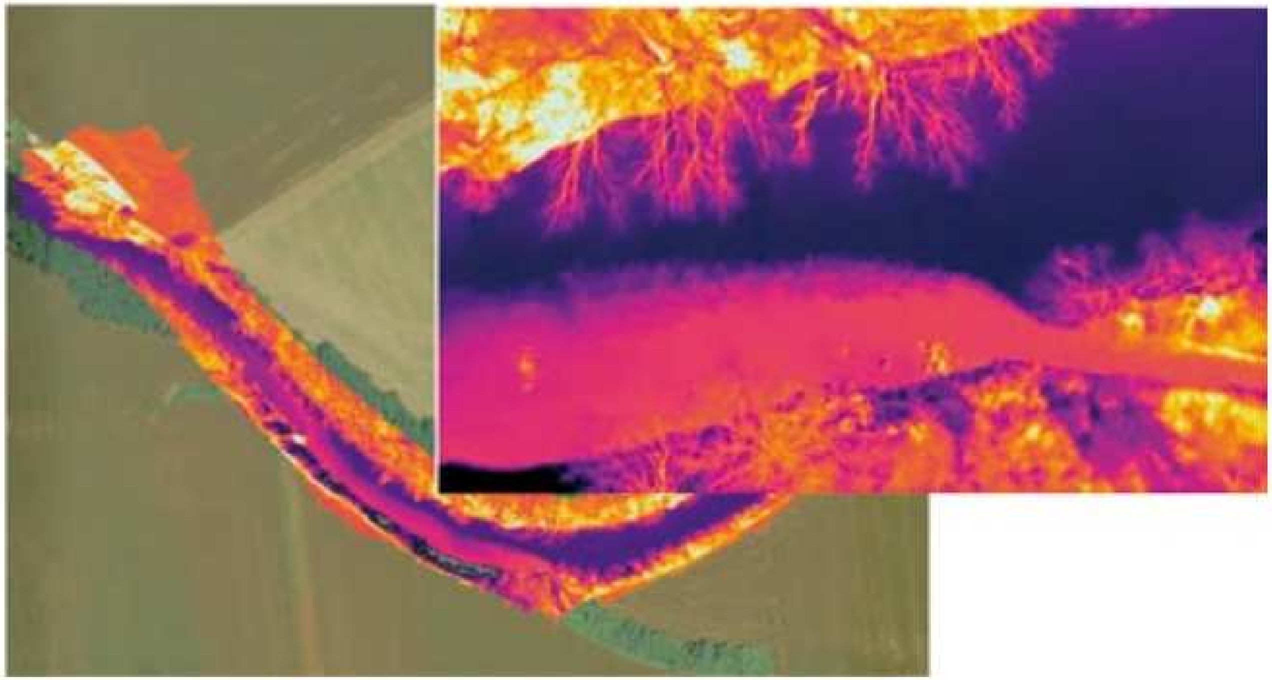
http://www.lifeaguas.es/theme/lifeaguas/files/pdfs/Layman_LIFE_AG_UAS_es.pdf

4. Detección de vertidos y emisiones en aguas superficiales

La finalidad de esta aplicación es demostrar la capacidad de la metodología para la identificación y control de emisiones en aguas superficiales, facilitando el cumplimiento de lo establecido en la Directiva Marco del Agua.

Mediante el sensor remoto (IR-8-12 µ) se pueden detectar fácilmente este tipo de vertidos, debido a la diferencia de temperatura entre el vertido y las aguas superficiales receptoras.

El resultado es una imagen que suministra información espacial del vertido.



Detección de vertidos en el río Arga

http://www.lifeaguas.es/theme/lifeaguas/files/pdfs/Layman_LIFE_AG_UAS_es.pdf

5.-CONTAMINACIÓN DE AGUAS MEDIANTE TELEDETECCIÓN

Universidad de Alcalá

FACULTAD DE BIOLOGÍA, CIENCIAS AMBIENTALES Y QUÍMICA

GRADO EN CIENCIAS AMBIENTALES

TRABAJO DE FIN DE GRADO

El humedal de las Lagunas de Puebla de Beleña:
Seguimiento de su comportamiento geohidrológico mediante imágenes Landsat 8 y aproximación al estado microbiológico de sus aguas

Autor: María Cabañero Recuero
Tutores: Silvia Martínez Pérez y Antonio Sastre Merlín
Asesor Técnico: José Antonio Domínguez Gómez.

2014

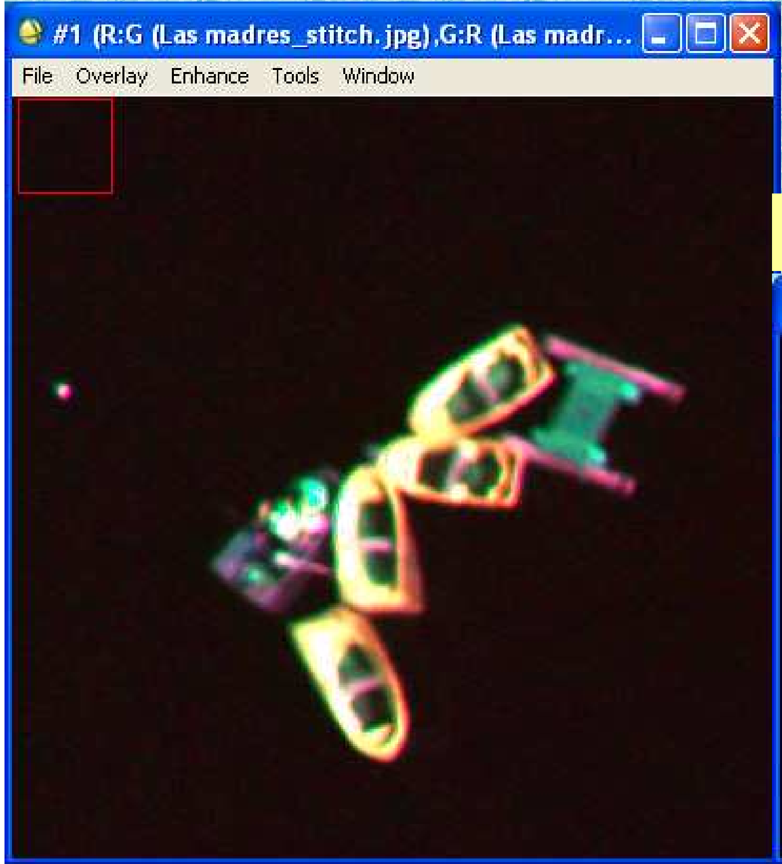
El humedal de las Lagunas de Puebla de Beleña:
Seguimiento de su comportamiento geohidrológico mediante imágenes Landsat 8 y aproximación al estado microbiológico de sus aguas.

6.- CONCLUSIÓN

Proyecto de I+D INTELECTA

http://www.zumain.es/

Muestreo 29 Octubre 2014



6.- CONCLUSIÓN

GloboLakes

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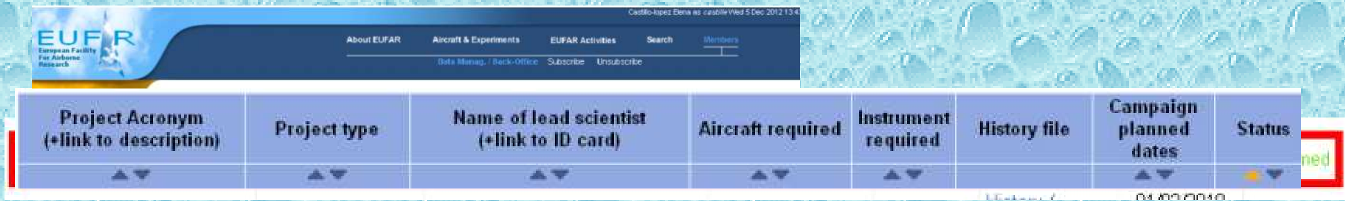
NOW



AIRES-CZM EUFAR Project

HYPERSPECTRAL AISA-EAGLE IMAGES (18/07/2010)

PI: Dra Elena Castillo (elena.castillo@unican.es)

6.- CONCLUSIÓN

Remote Sensing as a tool for the management of Spanish Aquatic Ecosystems

FUTURE

Asociación Española de Teledetección

Inicio | Presentación AET | Área de Socios | Publicaciones AET | Grupos Temáticos | Red Nacional de Teledetección | Preguntas

Inicio de sesión

Principal

GRUPOS TEMÁTICOS

Docencia, Carlos Pérez

Algoritmos de tratamiento de imágenes, Mario Lillo Saavedra

Meteorología y Climatología, Francisco J. Tapiador

Teledetección marina, Carlos García Soto

Limnología y aguas continentales, Jose Antonio Domínguez Gómez

Cartografía temática y topográfica, integración de datos y actualización , Luis A. Ruiz

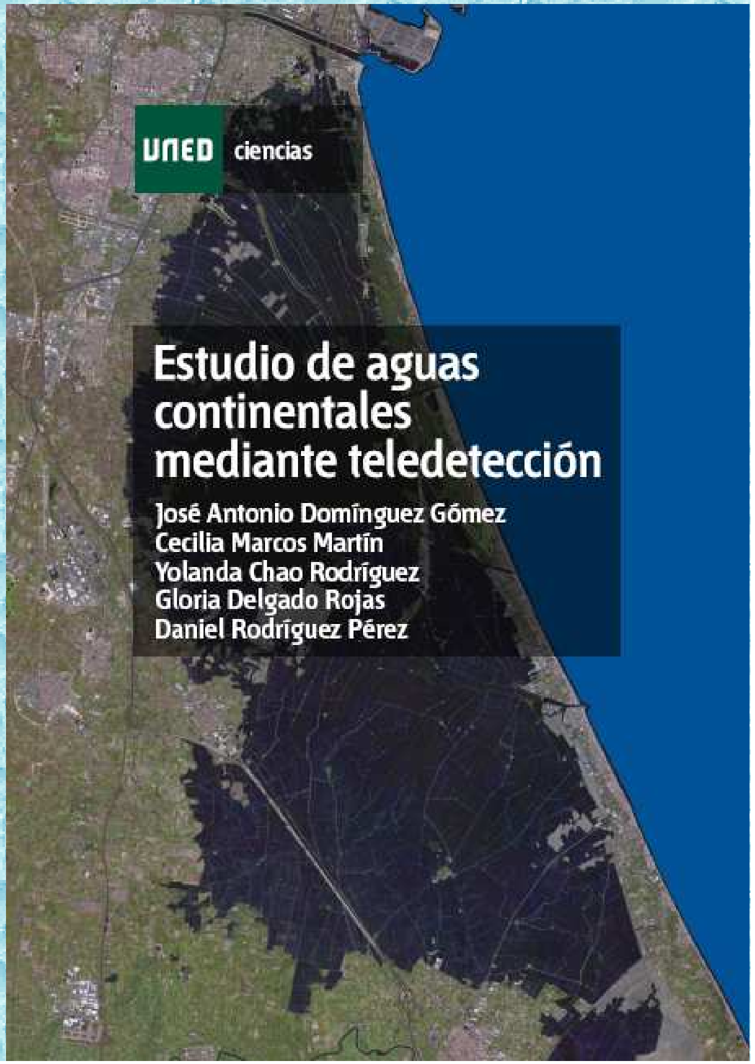
Aplicaciones agrarias, Alfonso Calera del Monte

Incendios forestales, Juan de la Riva

Espectroscopía de campo y laboratorio, Mª del Pilar Martín Isabel

Teledetección geológica, Juan P. Rigol Sánchez

Empresas e Industrias, Moisés Zalba Almándoz



6.- CONCLUSIÓN

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+About Observing the Earth

EO programmes
- The Living Planet
- Copernicus

ESA's Earth Observing missions
- Envisat
- ERS overview
- Earth Explorers overview
- Sentinels overview
- Proba-V
- Proba-1 overview
- Third Party Missions overview

ESA > Our Activities > Observing the Earth

TWO NEW EARTH OBSERVATION MISSIONS CHOSEN FOR FURTHER STUDY

26 November 2010 As part of the procedure to realise ESA's series of Earth Explorers, two new mission proposals have been selected for further development. The missions, called FLEX and CarbonSat, now vying to be the eighth Earth Explorer, both address key climate and environmental change issues.

The selection follows ESA's Call for Earth Explorer Proposals that was released in October last year and ended in the Agency receiving 31 high-quality mission concepts. Subsequently, the proposals were carefully evaluated by leading Earth scientists in four peer review panels.

This evaluation process, which included a

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Related News
- ESA issues call for Earth Explorer proposals
- Three ESA Earth science missions move to next phase

In depth
- Earth Explorers
- Future missions

Space for our climate

6.- CONCLUSIÓN

https://earth.esa.int/web/guest/missions/esa-future-missions/sentinel-3

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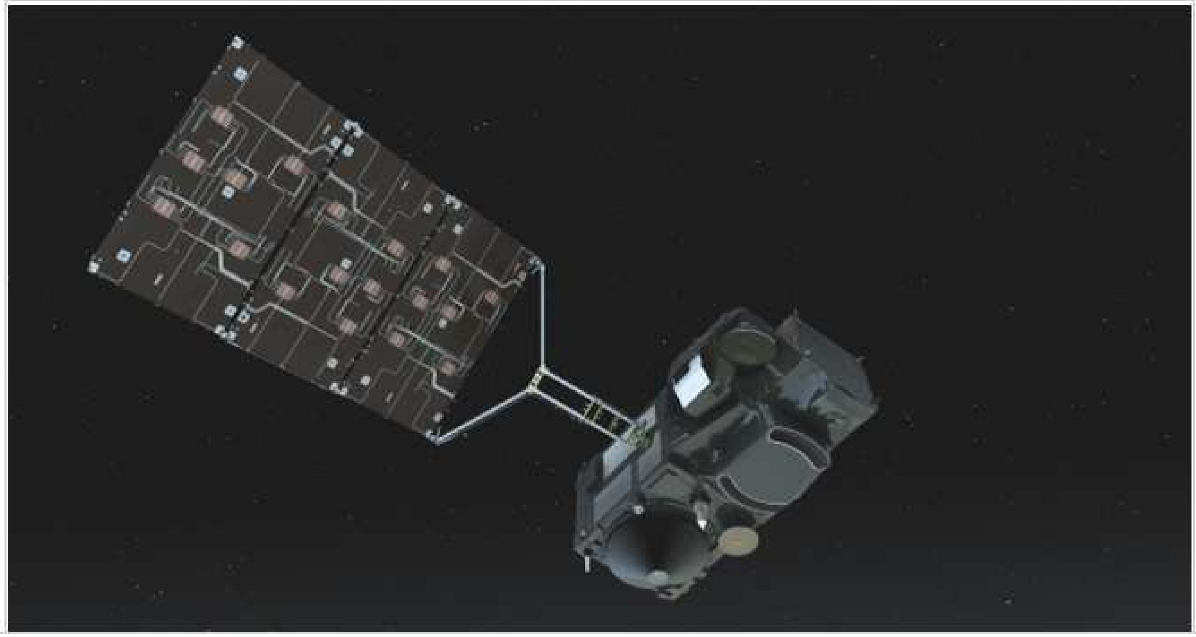
Sentinel 3

Introduction | Milestones

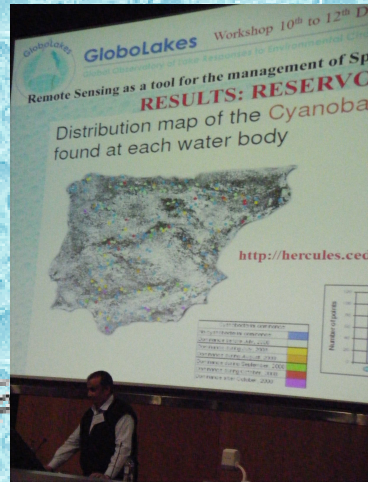


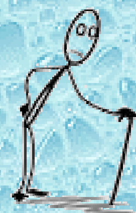
Missions

- Missions Home
- ESA EO Missions
- ESA Future Missions
  - Copernicus - Sentinels
    - Sentinel-2
    - Sentinel-3
    - Sentinel-4
    - Sentinel-5
    - Sentinel-5P
  - Earth Explorers
- 3rd Party Missions
- ESA Earth Observation Campaigns Data
- ESA/EUMETSAT
- ESA Mission Continuity
- ESA Mission News
- ESA User Services News

Documentation

6.- CONCLUSIÓN





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2014

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GRACIAS